Development of a Prototype Turbine to Harvest Electrical Energy from Residential Waste Water.

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January 2023

CONTENTS

CHAPTER 3

CHAPTER 4

List of Figure

List of Table

Table no Description **page no**

List of Chart

Chart no **Description** **page no**

Notations:

w = Specific weight of water.

H = Head of water (m)

Q= Flow rate of water

V= Velocity

D_T= Diameter of Turbine

d= Diameter of Nozzle

P= Power

V= Voltage

I= Ampere

ηT= Turbine Efficiency

ηG= Generator Efficiency

N= RPM

N_s= Specific Speed

N= Number of blades

ACKNOWLEDGMENTS

We are grateful to Prof. Dr. Md Alamgir Hossain, our supervisor at Sonargaon University, who always has helped us with all the problems we have had during the project realization, and has advised us in the best direction.

We want to express gratitude to Prof. Dr. Md Alamgir Hossain for all his help in the field of how to do management of the project. It will be very useful for us in the future time.

ABSTRACT

The project focused on design, fabrication and performance study on Development of a Prototype Turbine to Harvest Electrical Energy from Residential Waste Water. The project is an ongoing research project which created the necessity of newly designing all the parts, growing the output power of the project, make the whole structure bearable meantime maintaining the project within a very low cost.

The main objective is to enhance the efficiency of Development of a Prototype Turbine to Harvest Electrical Energy from Residential Waste Water in Sonargaon University campus: Several parameters have been analyzed with respect to velocity of water to determine the best value which would give the highest efficiency. A prototype of Turbine to Harvest Electrical Energy from Residential Waste Water was designed and turbine rotation (rpm) have been measured with changing its configuration. From the experiments, maximum turbine rotation (rpm) has been found as 63 rpm for the blade configuration (20). From the observed period average velocity of water was 3 m/s.

BACKGROUND

Hydropower started with the wooden waterwheel. Waterwheels of various types had been in use in many parts of Europe and Asia especially in Mesopotamia which are still in use till now on Euphrates River for irrigation and milling grain for some 2,000 years (see Fig. i).

By the time of the industrial revolution, waterwheel technology had been developed to a fine art and efficiencies approaching 70% were being achieved in the many tens of thousands of waterwheels that were in regular use. Improved engineering skills during the 19th century, combined with the need to develop smaller and higher speed devices to generate electricity, led to the development of modern day turbines. Probably the first hydro turbine was designed in France in the 1820s by Benoiˆ tFourneyron who called his invention a hydraulic motor. Towards the end of that century many mills were replacing their waterwheels with turbines and governments were beginning to focus on how they could exploit hydropower for large-scale supply of electricity.

Figure (i) Water wheel

The golden age of hydropower was the first half of the 20th century, before oil took over as the dominant force in energy provision. Europe and North America built dams and hydropower stations at a rapid rate,exploiting up to 50% of the technically available potential. Hundreds of equipment suppliers sprung up to supply this booming market. Whereas the large hydro manufacturers have since managed to maintain their business on export markets, in particular to developing countries, the small hydro industry has been on the decline since the 1960's. A few countries (notably Germany) have boosted this sector in recent years with attractive policies favoring 'green' electricity supply, but small hydro in general cannot compete with existing fossil fuel or nuclear power stations so that, without environmental incentives to use non-polluting power sources, there has been no firm market for small hydropower in developed countries for many years. The first hydroelectric power plant was installed in Cragside, Rothbury, England in 1870. Industrial use of hydropower started in 1880 in Grand Rapids, Michigan when a dynamo driven by a water turbine was used to provide theatre and storefront lighting. In 1881, a brush dynamo connected to a turbine in a flour mill provided street lighting at Niagara Falls, New York. The breakthrough came when the electric generator was coupled to the turbine and thus the world's first hydroelectric station of 12.5 kW capacity was commissioned on 30 September, 1882 on Fox River at the Vulcan Street Plant, Appleton, Wisconsin, USA lighting two paper mills

Energy Sci. & Tech. Vol. 1: Opportunities and Challenges and a residence. Early hydropower plants were much more reliable and efficient than the fossil fuel-fired plants of the day. This resulted in a proliferation of small- to- medium sized hydropower stations distributed wherever there was an adequate supply of moving water and a need for electricity. As electricity demand grew, the number and size of fossil fuel, nuclear and hydropower plants increased. In parallel, concerns arose around environmental and social impacts. Hydropower plants (HPP) today span a very large range of scales, from a few watts to several GW. The largest projects, Itaipu in Brazil with 14,000 MW and Three Gorges in China with 22,400 MW, both produce between 80 to 100 TWh/yr (288 to 360 PJ/yr). Hydropower projects are always site-specific and thus designed according to the river system they inhabit.

CHAPTER 1

INTRODUCTION

1.1 Background study

At present energy implementation is the most conversing topic in the world. A country's development depends on its power producing rate and its proper using because most of the industry run by the electricity. Bangladesh is a developing country where is the most important to increasing electricity production. To fulfill the demand of electricity it takes various steps to increase the production of electricity. Each country of the world has taken initiatives to increase electricity generation which leads to increase global warming now modern world feels to find new sources to stop global warming. Renewable energy is a solution to resolve this issue. Among various renewable energy sources, hydro energy holds good prospect in this regards. It is totally favorable to the environment as well as low producing cost.

At present Bangladesh has only one hydroelectric power station generating electricity by damming the Karnaphuli River, which produces a total of 230 MW of electricity. As it is the only hydroelectric plant, the use of hydropower in Bangladesh is very low.

The results of the hydro power resource assessment will help Bangladesh to overcome the significant energy challenges, the report said citing the country's power shortage against the backdrop of increasing demand and dwindling natural gas reserves. Data obtained for the study will support informed decision making ranging from policy and investment decisions to reliable power sector planning.

1.2 Hydro power probability in Bangladesh.

Due to lack of necessary head and space, the possibility of any new hydro power station in Bangladesh is very low. But we can use it in different ways. Which is the main objective of our project.

1.3 Importance of the project

Household hydropower systems provide energy by extracting power from high head water. Energy harvesting with water catchment from rooftops for individual buildings located in regions where typhoons or heavy rains are common. The gravitational potential energy of the rainwater would be converted to kinetic energy. The stream of water would strike a turbine to cause the turbine to rotate. The turbine would be connected to a generator to produce electrical power. The turbine would be placed in the downspout and above the storage tank, locations can vary depending on the type of the turbine used. For a roof area of 185 meters squared, and an average rainfall of 43 centimeters per year, the system was calculated to produce 1.5 kilowatt- hours per year. If the system was located in the rainiest locations on Earth, it would be able to produce 48 kilowatt-hours per year, this is equivalent to about 8,640 phone charges. In comparison to other forms of energy generation this is actually minimal, however for rainy climates with little electricity access the technology can be used to supplement other forms of energy. By using this project we can save electricity. We can have an extra energy source for our Daily purposes. We can recycle the water we waste everyday & make electrical Energy. We can use this energy on emergency like load-shedding, bad weather. It is also very eco-friendly project.it creates no harm in climate. We can also use this for such purpose like Door bell, step lights.

1.4 literature review

Water turbines work on a simple principle. First, the hydraulic energy of the water is converted into mechanical energy through a turbine. Its power is then transmitted through the shaft to the generator.

Different types of turbines are used on the basis of water head. For example Kaplan turbine is used for low head, Francis turbine for medium head and Pelton turbine for high head. The efficiency can be increased by changing the size and shape of the turbine and the blades. Designation of turbine and generator is very important for setting up a profitable hydroelectric power plant.In February 1981, the Water Development Board and Power Development jointly carried out a study on the assessment of Small/Mini-Hydropower Potential in the country [11].The committee explored 19 prospective sites for possible installation of small hydropower plants. Later in the month of April 1984, Six Chinese experts visited Bangladesh and them identified 12 potential sites for development of mini-hydropower plant. Out of these sites, only MahamayaChara, near Mirersharai, close to Dhaka-Chittagong highway was identified as the best site for development of small hydro. It requires potential utilization of hydropower and indigenous technical knowledge to utilize the existing opportunities in the CHT areas. Decentralization of micro-hydropower units with local implementation and management through self-reliance and the use of local natural resources will have significant impact on the remote tribal rural development. Mr. Aung ThuiKhoin set such an instance by setting up micro-hydro plant. The unit was constructed with wooden turbine and making an earthen dam on the flowing Harakhal at remote hilly region of Monjaipara, Bandarban. About 10 kW electricity is being generated by this micro-hydropower unit that has illuminated 40 households of that village. That led to an agreement between LGED and innovator Mr. Aung ThuiKhoin for a month long study. The objectives of the study were identification of micro-hydropower potential sites within the hilly regions and promotion of indigenous technologies for development of hydropower. Possible integration with power generation and irrigation schemes was also under consideration. From the study, some prospective sites for micro-hydro-power development in three districts of CHT region wereidentified with the help of LGED officials, local communities, and head man.

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Following are the sites that were identified. In 2004 sustainable Rural Energy, Local government Engineering Department has explored some potential micro-hydro sites in Chittagong which is listed in Tab l e 2 .Most of the potential sites are situated in the Chittagong hill tracts (CHTs). It requires potential utilization of hydropower and indigenous technical knowledge to utilize the existing opportunities in the CHT areas. Decentralization of micro-hydropower units with local implementation and management through self-reliance and the use of local natural resources will have significant impact on the remote tribal rural development. Mr. Aung ThuiKhoin set such an instance by setting up micro-hydro plant. The unit was constructed with wooden turbine and making an earthen dam on the flowing Harakhal at remote hilly region of Monjaipara, Bandarban. About 10 kW electricity is being generated by this micro-hydropower unit that has illuminated 40 households of that village. That led to an agreement between LGED and innovator Mr. Aung ThuiKhoin for a month long study. The objectives of the study were identification of micro-hydropower potential sites within the hilly regions and promotion of indigenous technologies for development of hydropower. Possible integration with power generation and irrigation schemes was also under consideration. From the study, some prospective sites for micro-hydro-power development in three districts of CHT region wereidentified with the help of LGED officials, local communities, and head man. The potential sites are given as follows in table e 3. “Feasibility Study on R&D of Renewable Energy (Solar,Wind, Micro-Mini-Hydro)” has been carried out by theInstitute of Fuel Research Development (IFRD) of Bang-ladesh council of Scientific and Industrial Research (BCSIR).Various data are collected through the related instrumentsregarding the Micro-Mini-Hydrostudy at two selected placesof (1) Shailopropat, Bandarban, and (2)

Madhobkundu, Moulibhibazar.The collected data and information are analyzed onvarious aspects at RET laboratory of IFRD. On the basis ofanalysis of collected data up to June 2001, it is expected that5to 10 kW capacity Micro-Hydropower plant at Sailipropat.

CHAPTER 2

Fundamental of hydroelectric power plant

2.1 General

Hydropower or hydroelectricity is a renewable source of energy that utilizes the energy of fast-flowing water to generate electricity. The use of hydropower for various purposes is not a modern concept; its application can be seen even a thousand years ago. The ancient people used to run the wheels with the application of waterpower to grind grains and wheat into flour. Nowadays, modern hydropower turbines are used to utilize waterpower. The hydroelectric power plants generate electricity from the potential and kinetic energy of the water. It is one of the most cost-effective methods of electricity generation, which is why it is the most preferred and widely used as compared to other methods of electricity generation. As natural sources of fuels like oil, coal, and petroleum are exhaustible, hydroelectric power plants are very useful tomeet the high demands of electricity.

Figure 2.1 hydroelectric power plant.

2.2 Essential elements of hydroelectric power plant

Essential components of a hydroelectric power plant

1. Catchment area
2. Water Reservoir
3. Dam
4. Fore bay
5. Trash- Rack
6. Water-Way
7. Draft Tube
8. Surge Tank
9. Spillway

10. Powerhouse and Its equipment

11. Tailrace and head race

12. Head water control

2.3 Classification

The hydroelectric power plants are classified in three different aspects: the quantity of storage water in the dam, the available water head to produce mechanical energy and the nature of the electrical load on the plants. Each group is sub-classified in their own parameters.

2.3.1Based on water storage:

Hydroelectric plant without pond: In this kind of plants there is no possibility to store water so the plant works while there is water running along the river. Therefore the plant generates electricity whenever water is available. During rainy seasons the power output is the maximum possible because the flow is the highest, but when there is no water then any power is produced.

Run of river plant with pondage

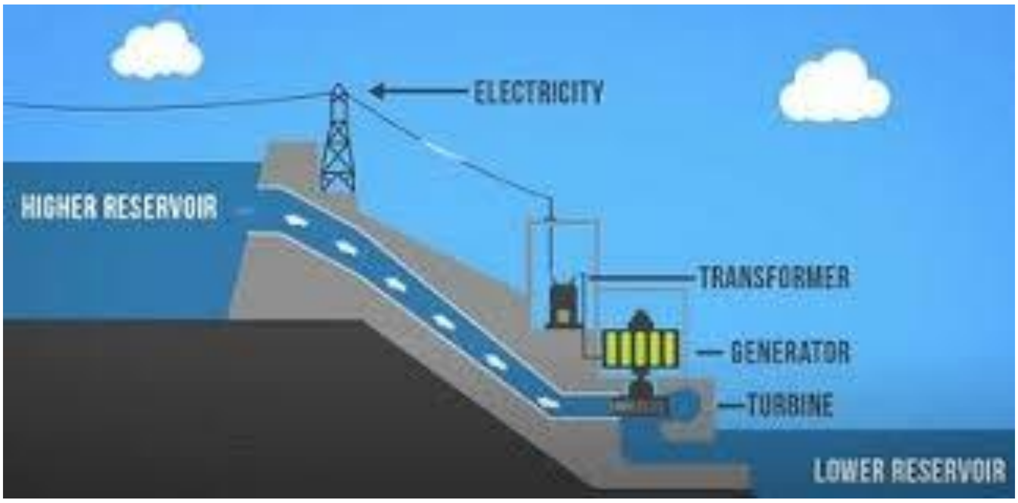

Figure 2.2 Run of reverse plants with pondage.

The usefulness of run-off river power plants is increased by pondage. Pondage refers to storage at the plant which makes it possible to cope, hour to hour, with fluctuations of load throughout a week or some longer period depending on the size of pondage. With enough pondage, the firm capacity of the power plant is increased. Such type of power plants can be used on parts of the load curve as required, within certain limitations and is more useful than a plant without pondage. Such power plants are comparatively more reliable and its generating capacity is less dependent on available rate of flow of water. Such power plants can serve as base load or peak load power plants depending on the flow of stream.

During high flow periods these plants may be used as base load and during lean flow periods these plants may be used to supply peak loads only. When providing pondage, tailrace condition should be such that floods do not raise the tailrace water level, thus reducing the head on the plant and impairing its effectiveness. Such plants offer maximum conservation of coal when operated in conjunction with steam power plants.

Run of reverse plants without pondage

Figure 2.3Run of reverse plants without pondage

Some hydro power plants are so located that the water is taken from the river directly, and no pondage or storage is possible. Such plants are called the run-off river power plants without pondage. Such plants can use water only as and when available; these cannot be used at any time at will or fit any desired portion of the load curve. In such plants there is no control on flow of water. During high flow and low load periods, water is wasted and during the lean flow periods the plant capacity is very low. As such these plants have a very little firm capacity. At such places, the water is mainly used for irrigation or navigation and power generation is only incidental. Such plants can be built at a considerably low cost but the head available and the amount of power generated are usually very low.During floods, the tail water level may become excessive rendering the plant inoperative. The main objective of such plants is to use whatever flow is available for generation of energy and thus save coal that otherwise be necessary for the steam plants. During the high flow periods such plants can be employed to supply a substantial portion of base load.

Pumped storage plant

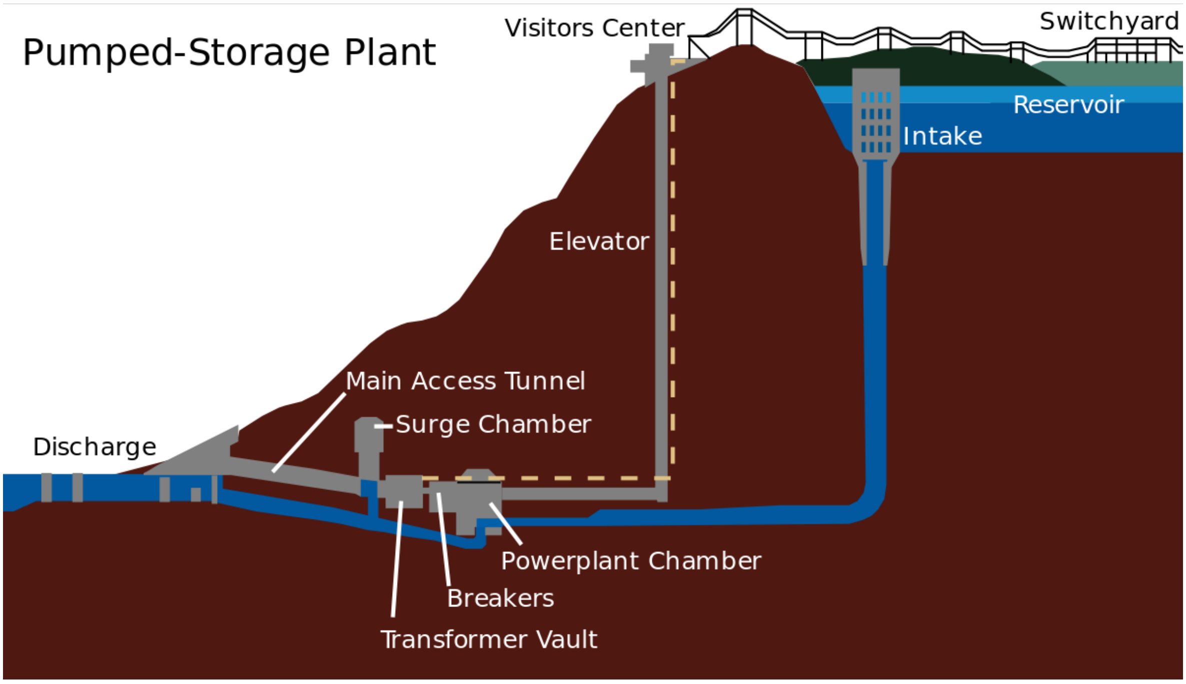

Figure 2.4 Pumped storage plant

Pumped storage hydro (PSH) is a large-scale method of storing energy that can be converted into hydroelectric power.

The principle is simple. Pumped storage facilities have two water reservoirs at different elevations on a steep slope. When there is excess power on the grid and demand for electricity is low, the power is used to pump water from the lower to the upper reservoir using reversible turbines. When demand is high, the water is released downhill into the lower reservoir, driving the turbines the other direction to generate electricity.

Pumped storage hydro plants can also provide ancillary services to help balance the power system, such as inertia from spinning turbines, which ensures the system runs at the right frequency and reduces the risk of power cuts.

2.3.2 Based on the head of water available:

1) Small head:

For the low head hydroelectric power plants, the existing waterfall is lower than 30 meters. Usually in this type of plants the dam is very small or even there is no dam and the production of electricity is only when is flowing enough water from the river. Therefore they produce only during the seasons when sufficient flow is going through the plant.

2) Medium head:

The head of this sort of plants is between 30 and 300 meters. Thus is why medium hydroelectric plants are situated on mountainous areas where the reservoir can be enough to produce energy not just during the raining seasons. They can also store water.

3) High head:

The head of water here is the highest, more than 300 meters and also it is possible to have more than 1000 meters. These plants are the most common hydroelectric plants. Huge dams are built across the way of the river, and they have a large reservoir, so they can produce electricity during the whole year and fill them up during the raining season. They are the most constructedhydroelectric plants because they can adapt easily to the required loads of the grid, peaks and basis loads.

2.3.3 Based on the nature of load:

1) Base load:

The base load type of hydroelectric power plants produces power all the time without taking care of the loads of the grid. They stop the production during maintenance. Although, they usually have another unit which keep producing while the other one is being repaired. The goal of run the power plant continuously is because produce the energy is very cheap. The majority of the power in the main grid comes from the base plants which handle a constant power output during the whole time. If there are any fluctuations on the energy demand then the smaller plants, that can be easily started and stopped, cover these peaks. The thermal and nuclear power plants are base type but also a lot of hydroelectric plants.

2) Peak load:

Although most of the energy demand is covered by the base plants, there are hours during the day when more power is needed. Then is time to start running the peak load plants which the production of electricity is more expensive but they can be started and stopped easily so they do not produce during a long time. Hydroelectric power plants can be one of these plants but also diesel power plants.

2.4 Working principle of hydroelectric power plant

To understand the working principle of the hydroelectric power plant, let's first understand the potential energy and the kinetic energy.

Potential energy: It is the energy possessed by the body due to its position relative to the other objects. When the objects are displaced from their equilibrium, they gained some energy, which gets stored in the objects in the form of potential energy. For example, when the spring is stretched or compressed, it gains potential energy, and when you throw the ball to another person, the ball has more potential energy when it is in the air than the energy it possesses when it falls on the ground.

Kinetic Energy: It is the energy possessed by the body due to its motion, i.e., the higher the speed of the body, the higher will be the kinetic energy.

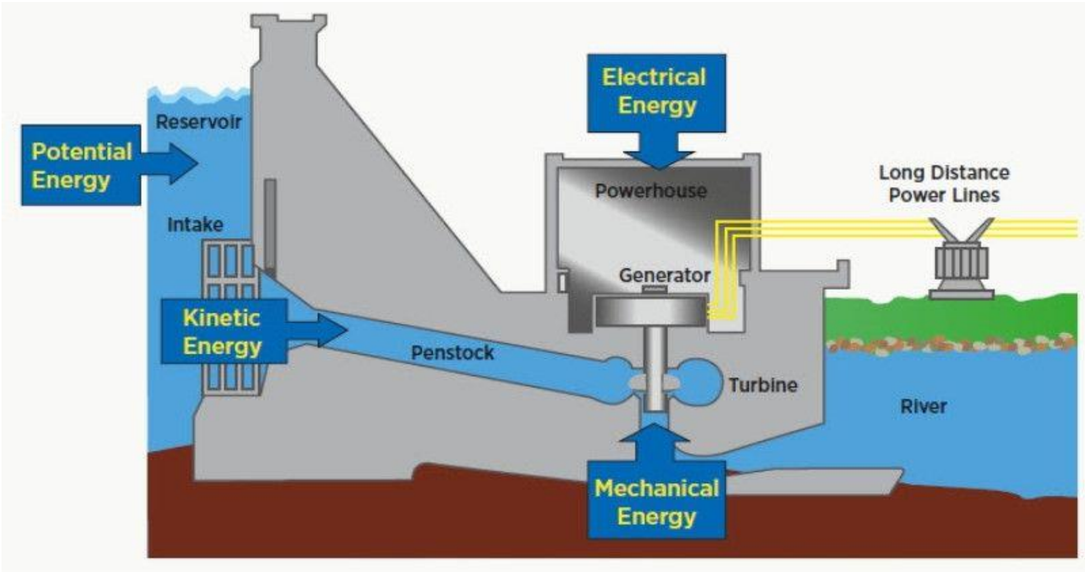

Figure 2.5 Energy Conversion of Hydro power plant

The working principle of the hydroelectric power plant is that it converts the potential energy (due to the elevation of water from the channel) and the kinetic energy (due to fast-flowing water) of the water into mechanical energy with the help of turbines. The water that is stored in the reservoir or fore bay behind the dam falls through the penstock, and it strikes the blades of the turbine with high pressure, and the turbine runner starts rotating.

The runner is attached to the central shaft that is connected to the generator, which eventually generates electricity, i.e., the turbine's mechanical energy is converted into electricity through electric generators. The electrical energy obtained is then supplied for domestic or industrial uses through the transmission lines after the voltage regulation by the transformers. The electrical energy obtained through the hydroelectric plants is proportional to the rate of flow of water and the elevation drop.

CHAPTER 3

Hydro power plant Kaptai Karnafuli

3.1 Hydropower Station:

Figure 3.1 Hydropower Station kaptai

Karnafuli Hydropower Station the only hydropower plant in the country is located at kaptai, about 50 km from the port city of Chittagong. This plant was constructed in 1962 as part of the 'Karnafuli Multipurpose Project', and is one of the biggest water resources development project of Bangladesh.

After being commissioned in 1962, the plant could feed the national grid with 80 MW of electricity. In later years, the generation capacity was increased in two phases to a total of 230 MW. The plant not only plays an important role in meeting the power demand of the country but is also vital as a flood management installation for the areas downstream.

3.2 Power generation:

The project was inaugurated in early 1962, with two of its three planned generators putting 80 MW of electricity into the national power grid. The third generator of 50 MW started power generation in January 1982. A feasibility study revealed that the reservoir had a 25% higher capacity than what was originally computed. The operating data also revealed a higher value of inflow than had initially been calculated. In order to exploit this additional potential, two more generators having 50 MW capacity each was installed in 1988. The present generation capacity of the karnafuli hydro power station is 230 MW during peak load hours.

Karnafuli Hydropower Station:

The power available from this dam has accelerated the establishment and expansion of industries in Bangladesh and has resulted in an appreciable saving in foreign exchange required for the import of manufactured goods. The power generated also permits pumping of water to achieve widespread irrigation and drainage. The reservoir storage designed to prevent serious flood has already saved the city of Chittagong from severe damage. The Kaptai Lake continues to serve as a good and important source for fish production. Recent study in 2007 showed that 74 freshwater fish species and 2 prawn species are available. In the year 2007-2008 about 8250 MT of fishes are produced by Kaptai reservoir.

Right above the dam there is the unending vista of a smooth sheet of water up to all conceivable corners of chittagong hill tracts made negotiable by launches, boats and other craft to the farthest Barkla rapids to the east and Kasalong forest reserves to the north, past rangamati. At Kaptai, all floating cargoes are transported across the dam by electric overhead trolleys.

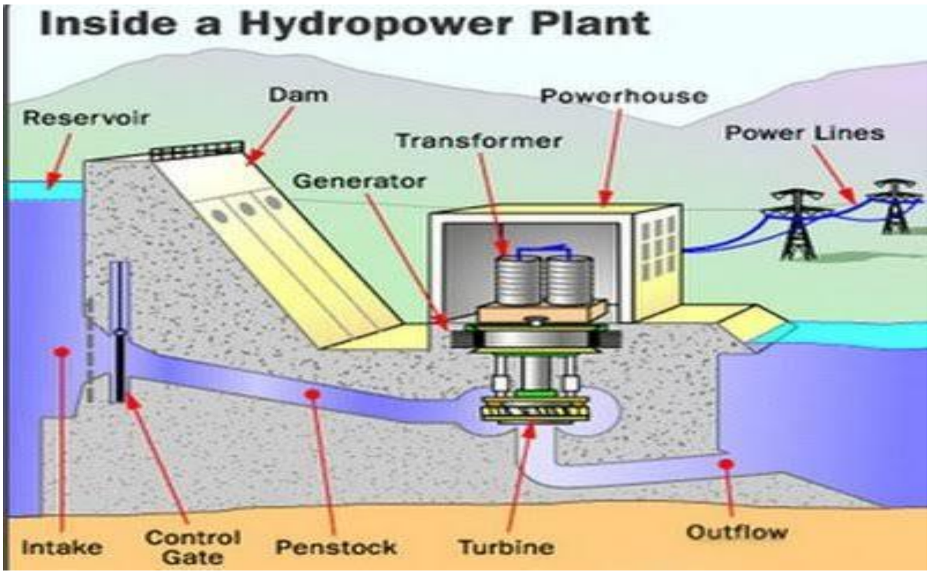

Figure 3.2Inside view of a hydropower plant.

3.3 Reservoir

Total capacity: 6477000000 m^3 (5251000 acre feet)

Catchment Area: 11000 km^2

Normal elevation: 33m

3.4 Dam and Spillways:

Type of dam: Embankment

Impounds: Karnafuli River

Height: 45.7 m (150 ft)

Length: 670.6 m (2200 ft)

Width: 7.6m (25 ft)

Width (base): 45.7 m (150 ft)

Dam volume: 1977000 m3

Spillway type: Controlled, 16 gates

Spillway capacity: 16000 m3/s (570000 cu ft/s

Figure 3.3 Dam of Hydropower Station kaptai

3.5Total Cost:

The total cost of unit 1, unit 2 and unit 3 was Rs 503 million and total cost was Tk 1900 million.

3.6 Turbine generator of kaptai hydro power plant:

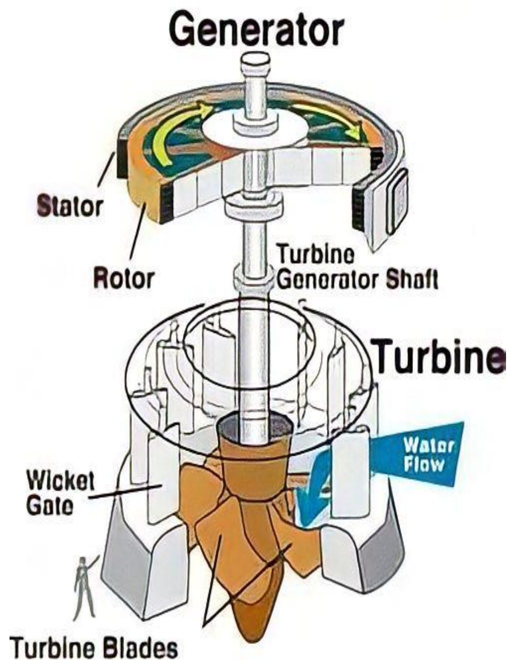

Figure 3.4Turbine generator of kaptai hydro power plant:

3.7 Why kaptai hydro power plant used in Bangladesh:

The primary purpose of the dam and reservoir was to generate hydroelectric power. Construction was completed in 1962, in then-East Pakistan. The generators in the 230 megawatts (310,000 hp) Karnafuli Hydroelectric Power Station were commissioned between 1962 and 1988.

CHAPTER 4

Design and Implementation

4.1 Introduction

Here the connection method and function of different parts of the project are discussed. Which gives us an idea about this project. In this method the turbine first uses the kinetic energy of the water to generate mechanical power. The mechanical energy of the turbine is then sent through the shaft to the generator which produces electrical energy.

4.2 Mechanical parts

4.2.1 Turbine

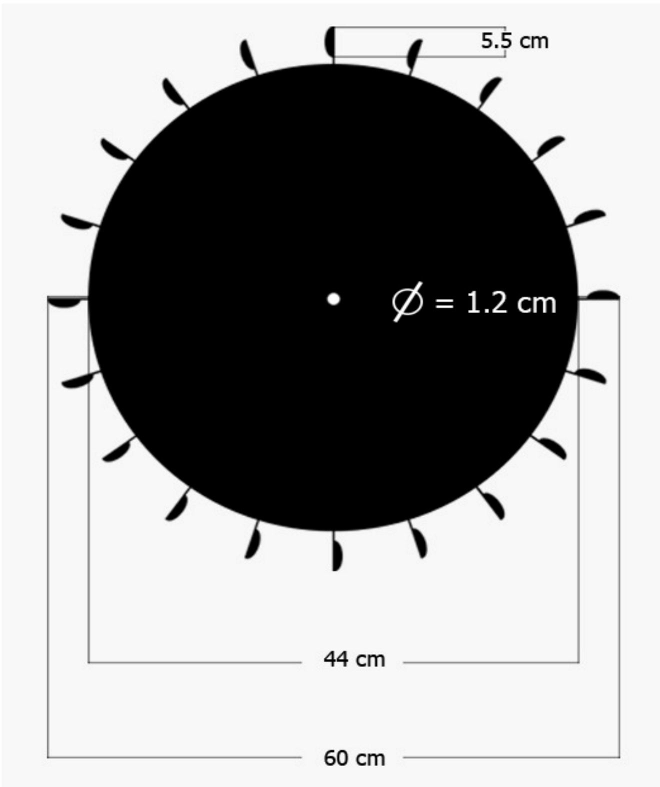

Figure 4.1 Design of water turbine

A rotating machine that is used to change the energies of water like kinetic & potential into mechanical work is known as a water turbine. These are used mostly in the dams for the generation of electric power using the potential energy of the fluid. Modern water turbines operating efficiency is higher than 90%. This turbine diameter is 60cm and use 20 bleeds. The Water turbine diagram is shown below.

4.2.2 Blade

In a Pelton wheel turbine, the runner or blade is a circular disc on the periphery of which several buckets evenly aligned are fixed. The bucket is a double hemispherical cup or bowl which is divided into two symmetrical parts by a dividing wall known as a splitter. Angle of every blade to another 18°.

4.2.3 Nozzle

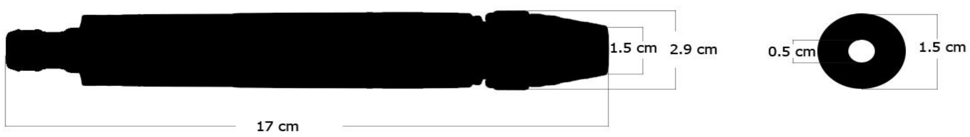

Figure 4.2 Design and construction of Nozzle

A nozzle is a device designed to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe. A nozzle is often a pipe or tube of varying cross sectional area and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. Nozzle with flow regulating device.

4.2.4 Ball Bearing

Figure 4.3: Design of Ball Bearing

A ball bearing is a type of rolling element bearing that uses balls to maintain the separation between the bearing races.

The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. In most applications, one race is stationary and the other is attached to the rotating assembly. As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction then if to flat surfaces were sliding against each other The model of the ball bearing is 6000ZZE which used in the project.

4.2.5 Shaft

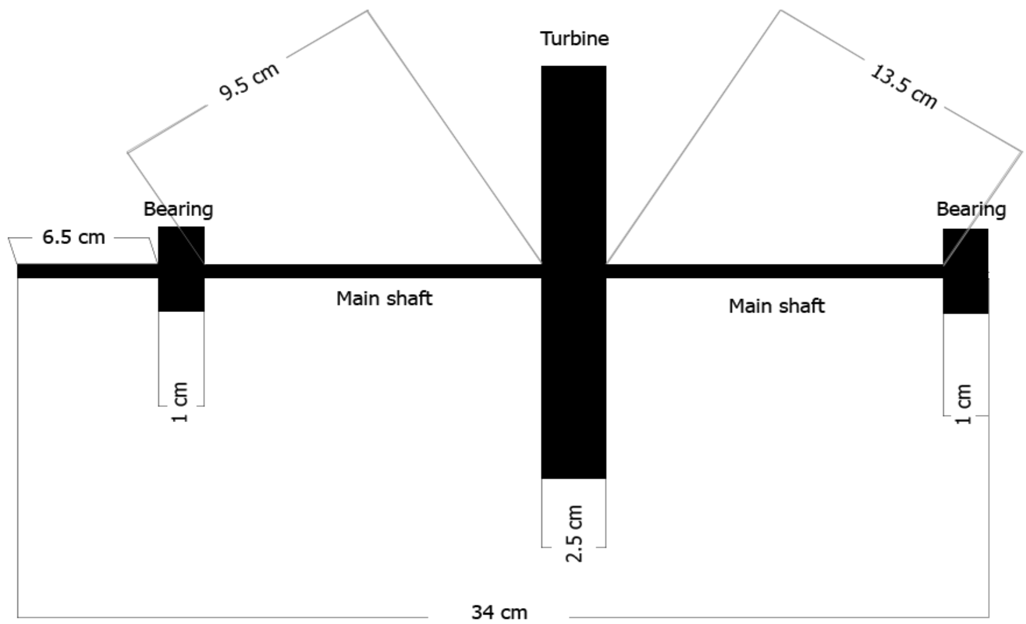

Figure 4.4: Design of Shaft

Shafts are spherical which are used to transfer rotational energy from one place to another. In a hydroelectric power station, the mechanical energy of the turbine goes to the generator through a shaft. The shaft used in this project has a diameter of 2 cm and a length of 30 cm.

4.3 Electrical Circuit and Parts

Electrical circuit of this project is given bellow.

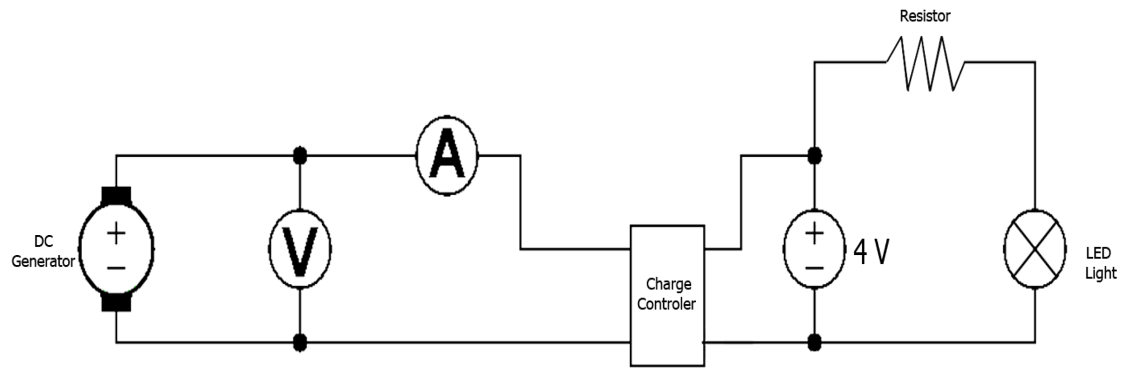

Figure 4.5: Electrical circuit.

4.3.1 Rechargeable Battery

A rechargeable battery is an energy storage device that can be charged again after being discharged by applying DC current to its terminals.

Rechargeable batteries allow for multiple usages from a cell, reducing waste and generally providing a better long-term investment in term parts dollars spent for usable device time. This is true even factoring in the higher purchase price of rechargeable and the requirement for a charger.

A rechargeable battery is generally a more sensible and sustainable replacement to one-time use batteries, which generate current through a chemical reaction in which a reactive anode is consumed. The anode in a rechargeable battery gets consumed as well but at a slower rate, allowing for many charges and discharges.

4volt rechargeable battery is used in this project.

4.3.2 Charge Controller

A charge controller is used to prevent the battery from overcharging. By using it the battery is protected. It reduces energy wastage. The circuit is safe using a charge controller.

4.3.3 DC Generator

DC generator or direct current generator generates a voltage when speed and flux are

Met. This machine is called a unidirectional (dynamo). It consists of the same basic elements

As a simple AC generator like the multi-turn coil rotating uniformly in a magnetic field.

The output of which is a series of emf pulses, all in the same positive direction resulting in

An average EMF developed across the load. Increasing the number of coils

Thereby smoothen the output providing more pulses at each revolution.This project uses a 6 volt and 2 ampere generator which is a DC generator

4.3.4 Voltmeter & Ampere meter

Figure 4.6 Voltmeter & Ampere meter

A Digital Voltmeter is used to measure AC or DC voltage consumed by an appliance and for displaying the value directly in numeric form instead of using a pointer deflection. It is thus, a voltage-sensitive device.

Ammeter, instrument for measuring either direct (DC) or alternating (AC) electric current, in amperes. An ammeter can measure a wide range of current values because at high values only a small portion of the current is directed through the meter mechanism; a shunt in parallel with the meter carries the major portion.

Model of the volt & ampere meter is HKS-AA028_V2.0.

4.3.5 Bread Board

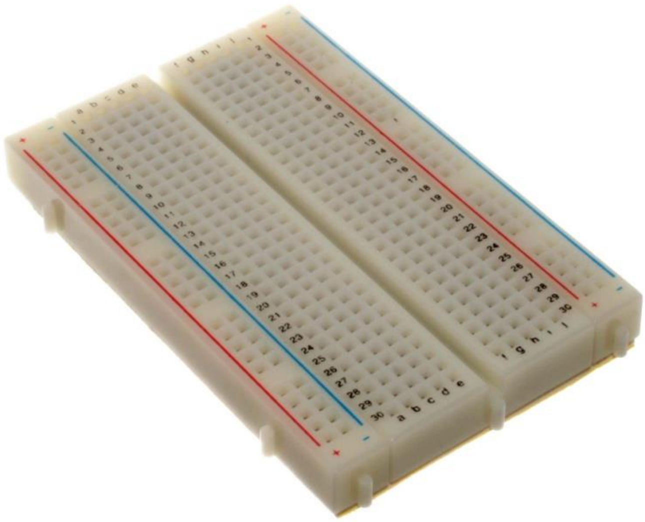

Figure 4.7 Bread Board

A breadboard is a rectangular plastic board with a bunch of tiny holes in it. These holes let you easily insert electronic components to prototype (meaning to build and test an early version of) an electronic circuit, like this one with a battery, switch, resistor, and an LED (light-emitting diode).

4.3.6 Capacitor

A capacitor is a little like a battery but works completely differently. A battery is an electronic device that converts chemical energy into electrical energy, whereas a capacitor is an electronic component that stores electrostatic energy in an electric field. In this article, let’s learn about capacitors in detail.

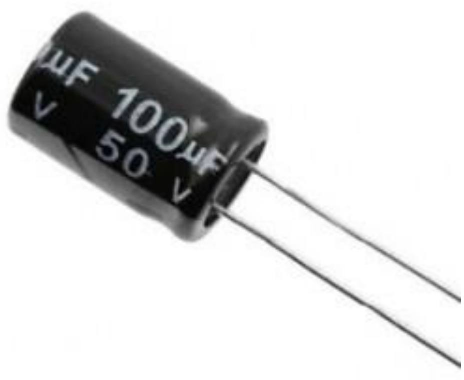

Figure 4.8 Capacitor

Different Types of Capacitors

The different types of capacitors are following.

1. Electrolytic Capacitor
2. Mica Capacitor
3. Paper Capacitor
4. Film Capacitor
5. Non-Polarized Capacitor
6. Ceramic Capacitor

4.3.7 Diode

A diode is a two-terminal electronic component that conducts current primarily in one direction; it has low resistance in one direction, and high resistance in the other.

Types of diodes

There are various types of diodes, some of them given bellow

1. Zener diode
2. Schottky diode

3. Light-emitting diode
4. Photodiode
5. Laser diode
6. Tunnel diode
7. Varactor diode
8. Avalanche diode
9. PIN diode
10. Gunn diode
11. Constant-current diode

4.3.8 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

4.3.9 LED

A light-emitting diode (LED) is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

4.4 Design of pipe

In actual use, the pipe should be designed in such a way that dirt does not flow through the pipe. In using the water filter, the waste should be put into a bypass line. The line will also be used as an overflow line. By this the water will get the necessary head and at the same time the dirt will also be removed. Which must be made during the construction of a building.

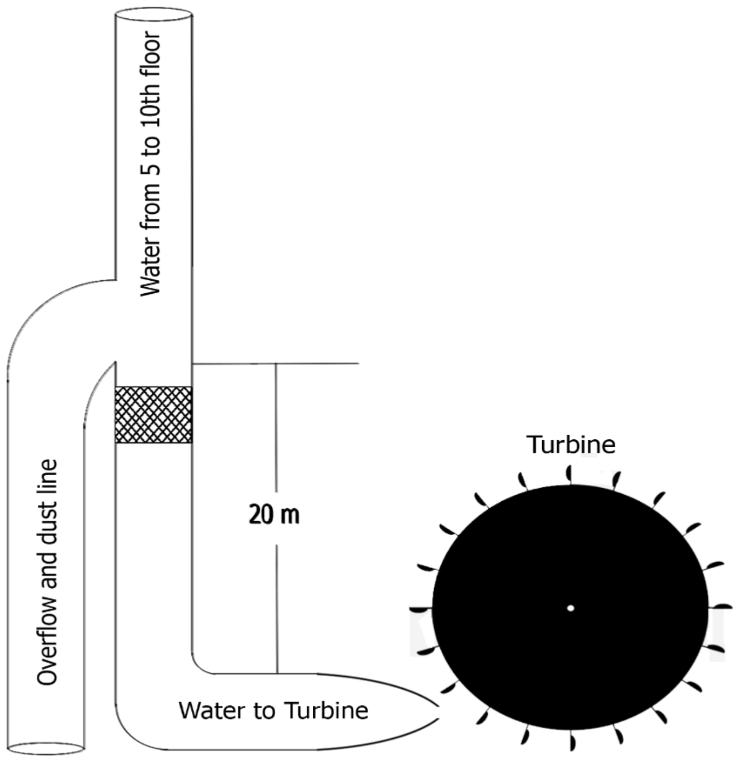

Figure 4.9 Design of pipe

4.5 construction of water turbine:

Figure 4.10 construction of water turbine

A plain plastic sheet was used for construction water turbine blades. It has to make its original shapes.

4.6 construction of rotating parts

After construction of the turbine, it is necessary to assemble to the main shaft according to the optimum design. The ball bearings are mounted to the main shaft to permit the rotation of the turbine on the support.

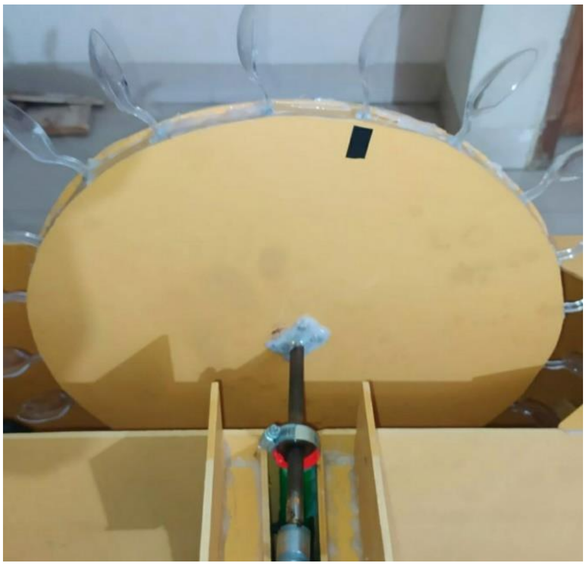

Figure 4.11 construction of rotating parts

4.7 Construction of power house

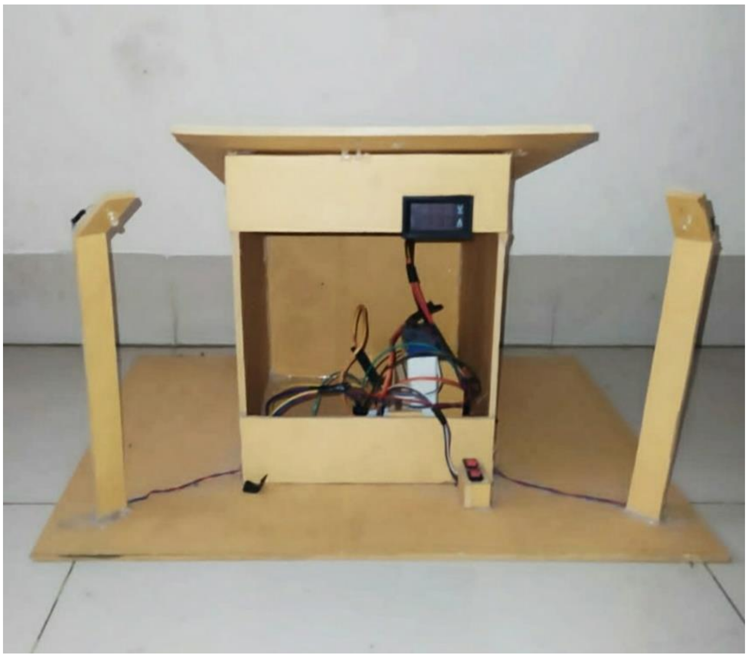

Figure 4.12 Construction of power house

The power house contains the storage battery and all the parts of the electrical circuit. Batteries are used to store the energy produced. The power house is usually away from the generator so the power house is designed separately.

4.8 Assembling the rotating parts, support and power house:

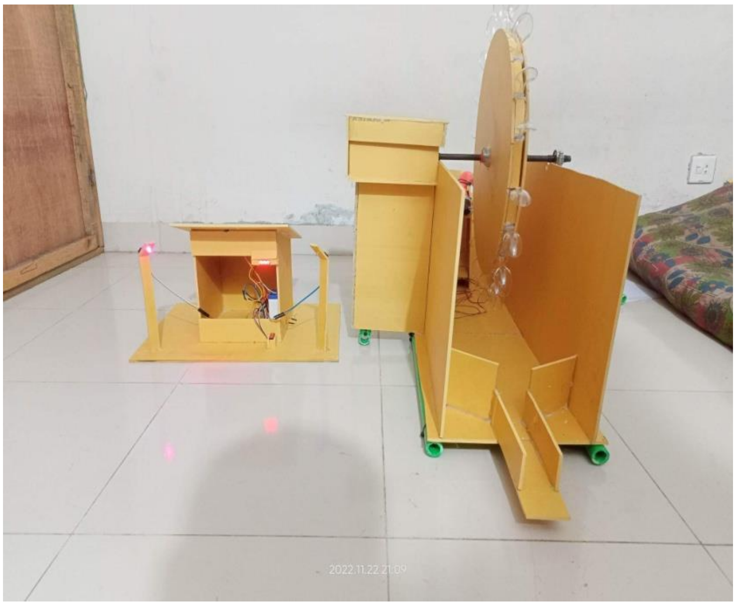

Figure 4.13 rotating parts, support and power house

After constructions of each parts as mentioned above, whole setup has been assembled together to complete the construction of whole water turbine.

Chapter 5

Performance Analysis

5.1 Performance test

After fabrication, turbine performance test has been carried out was measured. The performance was measured at

Different water condition to measure a turbine performance a several instrument was used. Such as voltmeter and ampere meter.

Name	
Voltmeter	A voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. A digital multimeter was used to measure voltage of the rotor.
Ampere meter	An ammeter (from Ampere Meter) 15 a measuring instrument used to measure the current in a circuit. Electric currents are measured in amperes (A), hence the name.

Generator

The conversion of rotational mechanical energy to electrical energy is performed by generator, Different types of generator have been used in hydro energy system over the years. Specification is given below which generator are used.

Table 5.1 Generator specification is shown below in:

Generator Type	Brushed DC Generator
Voltage	6V
Power	10 watt
Water velocity	3 m/sec
Output power	0.72 watt
Weight	200gm

Table 5.2 Performance of Turbine and Generator

Time	Water flow Rate (kg/min)	Velocity (m/sec)	Turbine rpm	Generator rpm	Voltage (v)	Ampere (A)	Theoretical power	Experimentalpower
5AM-8AM	3.3	2.8	62	248	4.6	0.14	4.312	0.644
9AM-2PM	3.5	3.0	64	256	4.8	0.15	4.573	0.720
2PM-5PM	3.1	2.6	60	240	4.4	0.13	4.051	0.572
6PM-9PM	3.2	2.7	61	244	4.5	0.13	4.181	0.585
9PM-12PM	2.8	2.4	57	228	4.2	0.11	3.659	0.462

5.2 Result and Discussion

(i) Theoretical power calculation:

The average water speed to be 3 m/sec and flow rate 3.5 kg/min.

Diameter of nozzle 0.5 cm.

Where

$P = Q\rho g H \eta_{over\ all}$

$=5.833X10^{-5} X1000X9.81X20X40$

$=4.5$ watt

Theoretical power=4.5 watt

$Q = 3.5/1000$

$=0.0035\ m^3/min$

$=5.833X10^{-5}$

$H = 20$ m

$\eta_{over\ all} = 40\%$

$P=1000kg/m^3$

(ii) Experimental power calculation:

$P = VI$

$= 4.8 X 0.15$

$= 0.72$ watt

V= 4.8 V

I= 0.15 A

Experimental power 0.72 watt

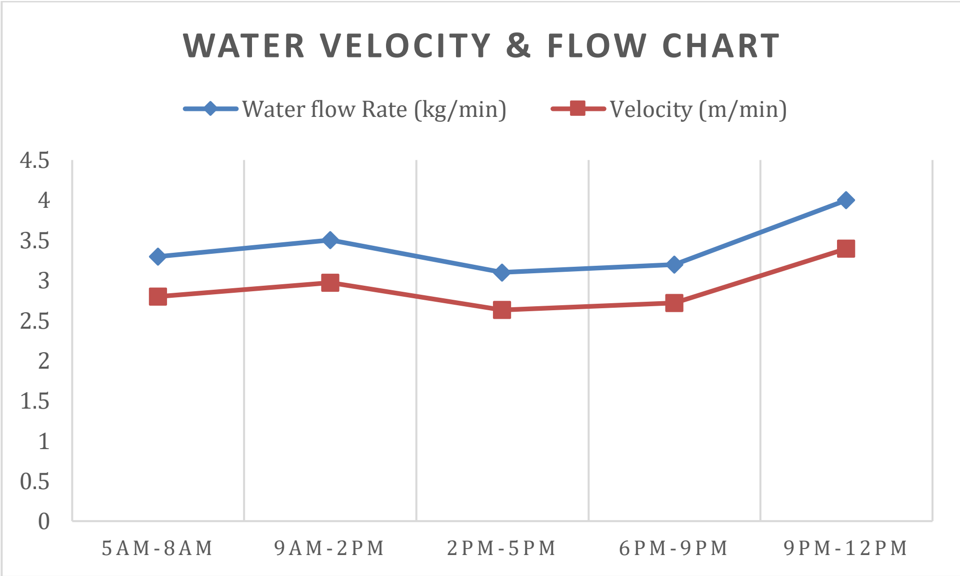

Chart 5.1 Graph at time, velocity & water flow rates

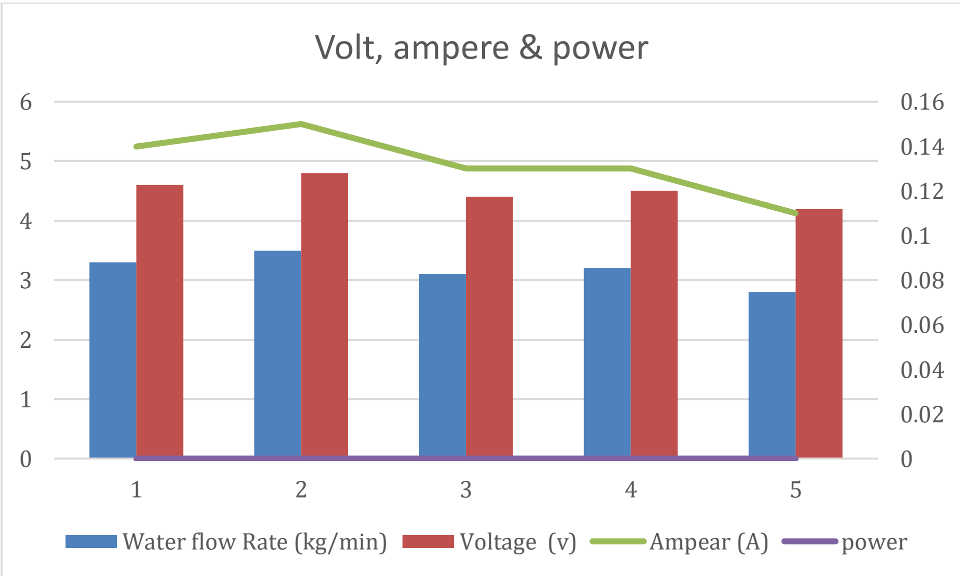

Chart 5.2 Graph at Volt, ampere & power

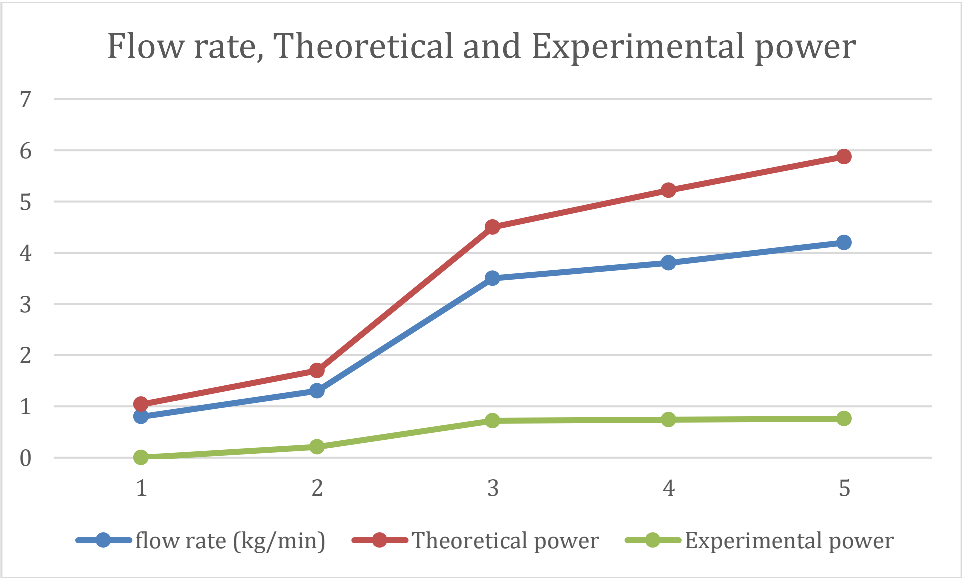

Chart 5.3 Graph at Flow rate, Theoretical and Experimental power

CHAPTER 6

Conclusion

6.1 Conclusion

The rapid increase in energy demand cannot be resolved easily until there is an alternative way to meet the demand. The micro power plant can undertake to solve this sort of situation in future. Hydro, Solar, wind and biomass energy is the main source of energy used for optimizing the overall system and hence to make it efficient. So the user will become less compulsive on the convenient fossil fuel energy. The stored energy also plays a significant role to avoid the imbalance of the power system.

The performance of a turbine constructed using waste water from a building of 10 floors or above to generate hydroelectric power has been successfully evaluated, measuring several parameters related to performance such as water velocity, turbine rotation, generator speed, generated voltage and power. For a few days from the observed data, the best performance was found for maximum turbine rotation (rpm) and maximum generated voltage of 65 rpm and 4.7 volts respectively. The average water velocity and average power generated over the observed time were 3 m/s and 0.72 W, respectively.

REFERENCES

1. Rachel Beckett, Erica Cooper, Sai Rachoor, Robert Romano, Dan Sutich, Kenny Wasserman and RamYamarthy, 2006. Renewable Energy Sources: Micro Hydro Power. Governor's School Research Journal, RutgersUniversity Busch Campus, Governor’s School Of Engineering And Technology, USA.
2. Energy efficiency and Renewable energy, 2007. Microhydropower systems, U.S Department of Energy.http://www. eere. energy. gov/consumer/your_home/ electricity/ index. cfm/.

   Answers. com, 2007. Micro Hydro. http://www. answers. com/topic/micro-hydro.
3. Hossain, A.K. and O. Badr, 2007. Prospects of renewable energy utilisation for electricity generation inBangladesh. Renewable and Sustainable Energy Reviews, 11(8): 1617-1649.
4. Bangladesh Bureau of Statistics, 2007. National data bank statistics. www. bbs. gov. bd.
5. Rofiqul Islam, M., M. Rabiul Islam and M. RafiqulAlam Beg, 2008. “Renewable energy resources andtechnologies practice in Bangladesh”, Renewable and Sustainable Energy Reviews, 12(2): 299-343.
6. Sustainable Development Networking Programme, 2007. Bangladesh: a very brief history. www. sdnbd.org/bangladesh.htm.
7. Energy Information Administration. Country analysis briefs: Bangladesh, 2007. http://www. eia. doe.gov/emeu/cabs/Bangladesh/Background.html.

8. World Bank, 2007. www. worldbank. org/data/ countrydata/countrydata. html.

Government of the People's Republic of Bangladesh, 2007. Bangladesh economic review.

Islam, M.N., 2000. Energy security issues of Bangladesh, Engineering News, Institute of EngineersBangladesh.

9. British Petroleum. B.P., 2006. Statistical review of world energy. B.P Plc.

The World Energy Book, 2005. World Energy Council, (1): 19.

10. Bangladesh Power Development Board, 2007. www. bpdb. gov. bd.

Bangladesh, 2007. Statistical Appendix, Prepared by WafaAbdelati and Erik Lueth (APD), Approved bythe Asia and Pacific Department, International Monetary Fund.

11. Micro-hydro power, 1989. Practical Action, The Schumacher Center for Technology &Development,Bourton Hall, Bourton-on-Dunsmore, Rugby, Warwickshire, UK.

12. Anderson, T., Doig, A., Khennas, S., Rees, D., Rural, 1999. Energy Services A handbook for sustainableenergy development, London: Immediate Technology Cop.

13. Micro Hydro Systems, 2007. http://www. matrixenergy. ca/ap/rp-micro-1.htm.

14. Fraenkel P., O. Paish, V. Bokalders, A. Harvey, A. Brown, R. Edwards, 1991. Micro-Htdro Power- Aguide for development workers, London: Immediate Technology Publications in association with the StockholmEnvironment Institute.

15. Phillip Maher., and Nigel Smith, 2001. Pico Hydro For Village Power - A Practical Manual for Schemesup to 5 kW in Hilly Areas, a project

funded by the UK Department for International Development (DFID),Edition, 20.

16. Micro Hydro Energy Potential in Bangladesh, published in February, 2006. at http://www. energybangla.com/article_print.asp?aId=116, access in July. 2007.
17. Sadrul Islam, A.K.M. Mazharul Islam, Tazmilur Rahman, 2006. Effective Renewable Energy Activities in Bangladesh, Renewable Energy, 31(5): 677-688.
18. Mini Hydro Power Generation in Bangladesh, 1981. Report of the Working Groups of Water DevelopmentBoard and Power Development Board, August.
19. Local Government, 2007. Engineering Department (LGED), Bangladesh, Micro Hydro Energy Potentialin Bangladesh, http://www. lged. org/sre/microhydropower. htm.
20. Local Government, 2007. Engineering Department (LGED), Bangladesh, Micro Hydro Development inBangladesh under SRE, http://www. lged. org/sre/microhy-sre. htm.
21. Reba Paul, 1999. Bamerchara Irrigation Project: A Potential Site for Mini Hydro Power Generation inBangladesh, Paper presented in the International Short Course on Small Hydro Power, Buet, 6-9.
22. Hasanuzzaman, M., J.K. Saha and M. Morshed, 2002. Micro- Mini Hydro Energy Prospects in SomeRegions of Bangladesh, Renewable Energy for Rural Development, A.K.M. Sadrul Islam & D.G. Infield (Eds).