P.E.S COLLEGE OF ENGINEERING

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(An Autonomous Institute Affiliated to VTU, Belagavi)

SYNOPSIS OF THE PROPOSED PROJECT WORK
ON

PORTABLE HYDROELECTRIC GENERATOR

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ABSTRACT

In the recent years, the environmental impacts are becoming difficult for developers to build new dams because of opposition from environmentalists and people living at that particular area due to the risk of relocation. the need has arisen to go for the small scale hydro power plants in the range of mini (few MW) and micro hydro (kW) power palnts with increased efficiency by considering the velocity distribution in field channels. The designed generator is considered for the experimental analysis in order to check for its working efficiency and finally adopting the specified diameter of inlet and outlet of the generator and the depth of flow to achieve high efficiency. The physical structure of the system is made of the non corrosive and unbreakable materials. It works, as it rotates in the water flow and does not require any kind of the external electric grid power for its working. As the water flows, the specially designed blades of the system rotate in the direction of the flow and ultimately the consistent power is generated. Using trial and error we can able to adopt the optimal diameter of the turbine and depth at which higher efficiency can be achieved.

Keywords: Portable hydroelectric generator, triangular notch, trapezoidal canal, D C Generator, velocity distribution, sustainable.

1. INTRODUCTION

Electricity is one of the main thing that human required to deal with their daily activities. Electricity can be generated by number of methods i.e. coal, geothermal, wind energy, solar energy, and hydropower generation. Hydro-electric power generation is very important to our nation. Growing population and modern technologies require vast amount of electricity for various activities.

Electricity is one of the most important blessings that science has given to mankind. It has also become a part of modern life and one cannot think of a world without it. Electricity has many uses in our day to day life. It is used for lighting rooms, working fans and domestic appliances like using electric stoves, A/C and more. All these provide comfort to people. In factories, large machines are worked with the help of electricity. Essential items like food, cloth, paper and many other things are the product of electricity. Modern means of transportation and communication have been revolutionised by it. Electric trains and battery cars are quick means of travel. Electricity also provides means of amusement, radio, television and cinema, which are the most popular forms of entertainment are the result of electricity. Modern equipment like computers and robots have also been developed because of electricity. Electricity plays a pivotal role in the fields of medicines and surgery too — such as X-ray, ECG. The use of electricity is increasing day.

The importance of electricity is unmatched by any other invention. The reason is that the discovery and invention of electricity and its practical use in daily lives have led to many other inventions and modernization. Even the technological revolution has been made possible because of the presence of electricity in our lives.

1.1.ELECTRICITY GENERATION IN INDIA:

India is the third largest producer of electricity in the world. According to data from Ministry of power, The total installed capacity is 408.71 GW as of October 31st, 2022. Renewable energy contributes about 40.7% of total installed capacity where the solar energy is estimated to contribute 61.62 GW, followed by 41.84 GW from wind power, 10.70 GW from biomass, 4.92 GW from small hydropower plant and 46.85 from large scale hydropower plant.

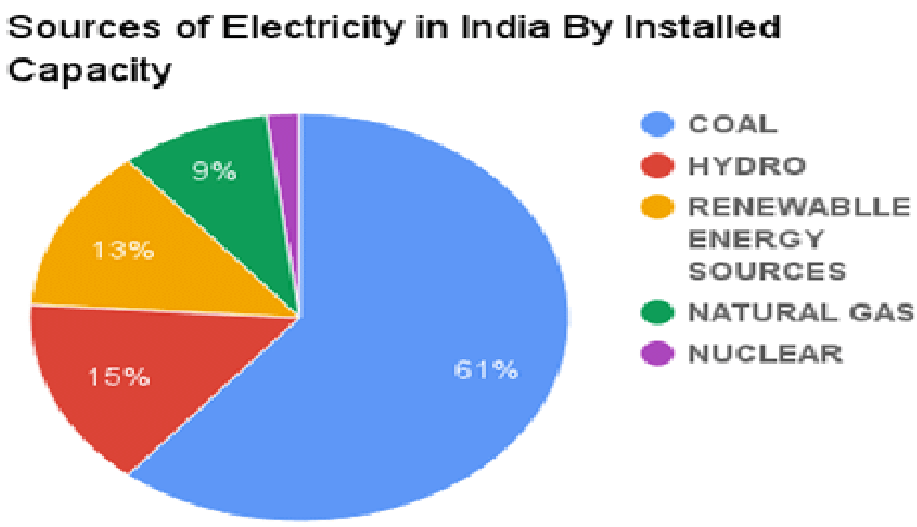

Fig 1: Power Generation In India

India has recorded rapid growth in electricity generation since 1985, increasing from 179 TW-hr in 1985 to 1,057 TW-hr in 2012.The majority of the increase came from coal-fired plants and non-conventional renewable energy sources (RES), with the contribution from natural gas, oil, and hydro plants decreasing in 2012–2017. The gross utility electricity generation (excluding imports from Bhutan) was 1,384 billion kWh in 2019–20, representing 1.0% annual growth compared to 2018–2019. The contribution from renewable energy sources was nearly 13% of the total. In 2019–20, all the incremental electricity generation is contributed by renewable energy sources as the power generation from fossil fuels decreased. During the year 2020–2021, the utility power generation has decreased by 0.8% (11.3 billion kWh) with a reduction in power generation from fossil fuels by 1% and power generation from non-fossil sources is more or less same of the previous year. In 2020–21, India exported more electricity than it imported from neighboring countries.Solar power generation in 2020–21, occupied third place after coal and hydropower generations surpassing wind, gas and nuclear power generations.

2. OBJECTIVES

The objective are divided as main objectives and specific objectives

3.1 MAIN OBJECTIVES

The main objective of the project is to develop a low cost Portable Hydroelectric Generator to generate electricity from irrigation canals to meet the emergency requirements of farmers and to utilize the energy of the flow of water in the irrigation canals. It is very important to find the environmental solution for the problem that occur in our daily life hence the portable hydroelectric generator acts as a eco friendly, small scale model for the production of electricity which aims at reaching the emergency requirements of the farmer and the people who are actually in the need. It is useful to fulfill the electricity need in the agriculture field with the affordable cost.

3.2 SPECIFIC OBJECTIVES

- To produce environmental friendly electricity
- To make more efficient
- To determine the depth of maximum velocity in irrigation canals
- To fix the diameter of inlet and outlet of generator by experimental analysis

3.METHODOLOGY

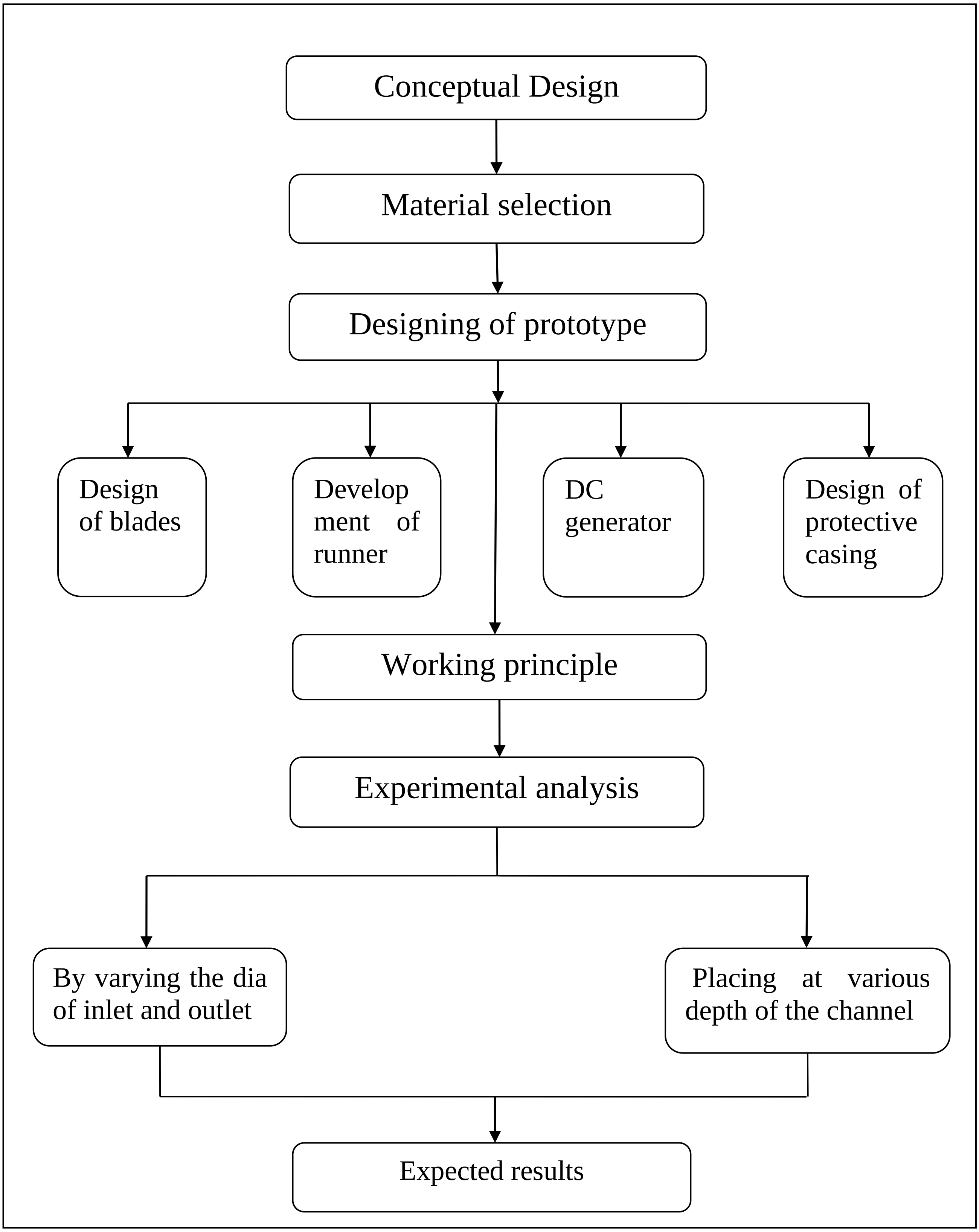

Figure 3: Flow chart on design of portable hydroelectric generator

3.1 CONCEPTUAL DESIGN:

Basically, applying the technical and engineering concepts during any design process makes one product more competitive than other. The main aim of the project is to design a low cost portable hydroelectric generator which utilizes the energy from the flowing water in irrigation canal. In this design various components of the portable hydroelectric generator are selected and arranged to generate the electricity. The efficiency of the generator is checked by varying the diameters of the inlet and outlet and placing it at various depth of the canal then the final results were evaluated by engineering analysis.

3.2 MATERIAL SELECTION:

Materials for the design of blades, shank, runner and casing were selected based on their resistance against the corrosion and their cost to make them cost effective. as it is portable, materials selected should make the generator light in weight.

3.2.1 Blades:

The design of the blade in fig does not just depend on the stress analysis but several other factors also play a significant role. The material that we selected for the design if blades is PVC materials which is available with a low cost and moreover it can be recycled for the concerned towards environment. It is also a resistant to the corrosion.

Figure4: Blades

3.2.2 Runner:

The runner is the rotating part of the turbine, which includes the hub, blades and shaft. Casting from metal is probably too expensive except for mass production. Hence a small light weight plastic material is selected for the design of runner.

3.2.3 D.C. Generator:

Generator converts mechanical energy into electrical energy. Generator plays vital role in generating the electricity. This change in the form of energy happens based on the principle of electromagnetic induction which means wherever a change in the magnetic flux happens associated with a conductor, an EMF or an electromagnetic force is induced in it. This induction causes a current to flow in case the conductor circuit is closed. A DC of capacity 6-24 volts ,10W generator is used to generate power.

Figure 5: D C Generator

3.2.4 Design Of Casing:

Casing is a protective cover provided which acts as scratch resistant and shock resistant. Hence, pvc pipe is selected as a casing material for the design of prototype.

Figure 6: pvc pipe for casing

3.2.5 Cable:

The electrical cable that is selected can handle output of current 1.14A-17A and voltage of 9V-16V. Ability to handle the minimum and maximum loads of generator is important because the system will be operating in different velocity and generate variety of loads.

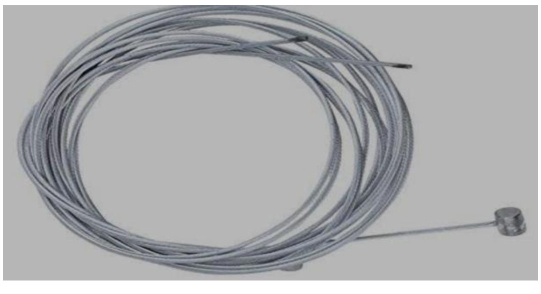

Figure7: Cable wire

3.3 DESIGN OF PROTOTYPE:

Design of prototype is the heart of the methodology part which plays the vital role in producing the portable hydroelectric generator.it includes the design of blades, determining the number of blades, shank, runner and finally the design of casing for proper protection for the DC motor.

3.3.1 DESIGN OF BLADES:

The design of the blade in fig does not just depend on the stress analysis but several other factors also play a significant role. The leading edge is kept thicker than the trailing edge for a streamlined flow and also to reduce the vibrations. This is incorporated in blade, by making it thicker near the flange and thinner towards the tip. In addition that, the blade has curved to take an advantage of the tangential velocity.

3.3.2 DESIGN OF RUNNER:

The runner is the rotating part of the turbine, which includes the hub, blades and shaft. Casting from metal is probably too expensive except for mass production. Since this is a prototype building, the runner parts are developed by conventional manner. Some of the machine tools which are used to produce The developing runner is shown in figure.

3.3.3 DESIGN OF CASING:

Casing is a protective cover provided which acts as scratch resistant and shock resistant. The main purpose of providing this is to keep the generator together and protect from collisions which might occur while carrying the portable hydro turbine. Casing should be designed such that it should make the whole assembly light in weight and should be economical. Hence the PVC is selected as casing material for the design of hydroelectric generator.

3.3.4 OVERALL DESIGN OF PROTOTYPE:

After the completion of the design of individual components required for the design of prototype, each and every components are arranged as per the design considerations for the proper working of the model. First And for most the blades have been designed as mentioned above which is connected to the shank and this assembly is known as runner. Runner is connected to the cable wire which is capable of taking the minimum and maximum load of generator. Blades are well protected by the casing and finally the cable is attached to the dc generator which is placed on the wooden plate for the protection and proper placing of the dc generator during the conduction of experiment.

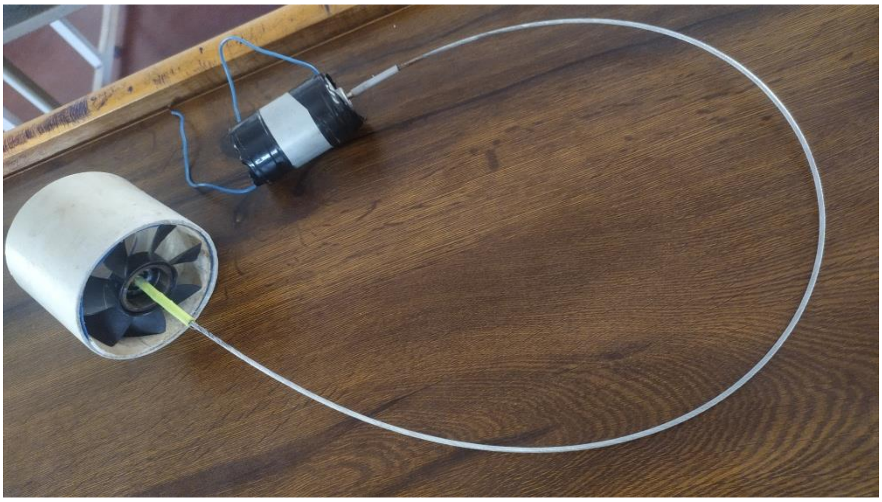

Figure 8: Final prototype

3.4 WORKING PRINCIPLE:

The Portable Hydro-Electricity Generator works on the principle that the electricity is generated using DC motor by stream flow pressure. It consists of DC motor, blades, runners, shank , Capacitor to control the electricity, casing for protection. Generator is placed across the flowing water at a various depth of its flow this blocks the flow and water get enters into the pipe then blades starts to rotate due the water pressure. This makes the DC motor to run continuously. The mechanical energy is finally converted into electrical energy by DC motors and the generated electricity can be used for various activities through cables.

3.5 EXPERIEMENTAL ANALYSIS:

The designed generator is considered for the experimental analysis in order to check for its working efficiency and finally adopting the specified diameter of inlet and outlet of the generator and the depth of flow to achieve high efficiency.

In order to determine the efficiency of the system and the total power output, one should calculate the voltage and amperage output of the generator. The value of amperage is proportional to the amount of torque the system generates, while voltage is proportional to the RPMs of the system.

Using trial and error we can able to determine the optimal diameter of the turbine and depth at which higher efficiency can be achieved.

The theoretical maximum power is the maximum power that can be generated if the turbine and generator are 100% efficient. This value helps to determine the actual efficiency of the system.

$$\mathbf{P = H * \frac{Ef}{11.8}}$$

Where,

P = maximum power.

H = Head value of water.

Ef = Effective flow rate of turbine.

3.5.1 Power output at various depth of flow

As we know that the velocity is not same at each depth of flow but varies from free surface to channel bed. since velocity is one of the prime factor that affects the efficiency of the generator, the power output is measured and computed in the table for the efficiency analysis. Finally the depth at which the power output is maximum is considered for the placement of portable hydroelectric generator.

We carried out the experimental analysis in the college laboratory in the open channel flume and the channel with rectangular notch and triangular notch. Where we could able to study the variation of velocity with respect to depth of flow. The electricity that produces is strongly depends on the velocity of flow. The maximum amount of electricity is produced at the depth at which the velocity is maximum.

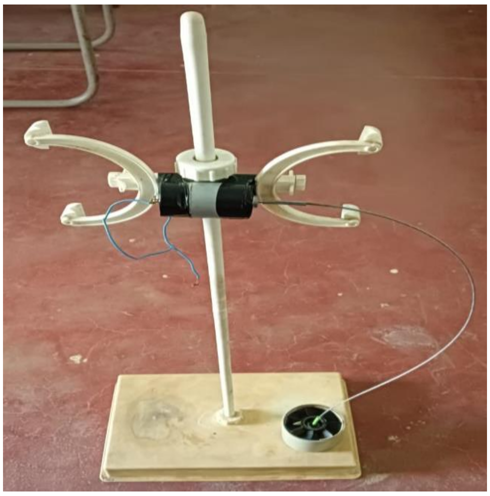

Figure 9: Final set up of the model

Figure10: at surface level

Figure11: at a depth 0.2y from surface level

Figure 12: At a bottom level

Then we carried out the analysis in the trapezoidal canal. Model is being placed in the two different depths one is at the free surface,and finally at the bottom of the channel. The voltage is measure using the multi-meter.

Figure 13: conduction in trapiziodal channel

Figure 14:Measuring the dimensions of the channel

Figure 15: At surface level

Figure 16 : At bottom of the channel

Then the experiment was carried out in the river. Model is being placed in the two different depths one is at the free surface,and finally at the bottom of the channel. The voltage is measure using the multi-meter.

Figure 17: glimpses of test conducted in river

Figure 11: glimpses of test conducted in river

VELOCITY CALCULATION:

Velocity at various depth can be measured using a mechanical devices like pitot tube and current meters etc… It can also be evaluated using the volts produced at the various depth of flow.

$$\boldsymbol{Velocity} = \sqrt{\frac{2 \times ev \times 1 \cdot 602x \cdot 1|0^{-19}}{mass\ of\ water}}$$

Mass of the water (H_2O) = 2x1u + 1x16u

= 2+16

=18 g/mole

1ev = 1.602x 10^{-19} J

1 V = $\frac{E\ (J)}{Q(C)}$

1V = $\frac{1.6X10-19}{1.602\ X\ 10-19}$

1V = 1 ev

4. RESULTS:

4.1 Laboratory experiment

We carried out the experiment in college laboratory in the channel with triangular notch in which the discharge has been calculated using the following formulae.

1. Total depth of the channel= 0.52 m
2. Length = 0.48m
3. Head of water = 0.223
4. Discharge, Q = $\frac{8}{15}\ X\ \sqrt{2g}\ X\ tan\theta\ X\ H\ ^{5}/_{2}$

$= \frac{8}{15}\ x\ \sqrt{2x9.81}\ x\ \tan(45)\ x\ 0.22\ ^{5}/_{2}$

= 0.053 m^3/sec

= 1.87 cusecs

TABLE1: Representation of results of experiment conducted in laboratory

SLNO	Depth(y= overall depth of the channel)	Depth in m	Velocity in m/sec $\boldsymbol{Velocity} = \sqrt{\frac{2 \times ev \times 1 \cdot 602x \cdot 10^{-19}}{mass\ of\ water}}$	Voltage in v
1	0	0	3.36	6.35
2	0.2y	0.104	4.21	9.96
3	0.6y	0.31	3.4	3.85
4	0.8y	0.41	0.79	0.35

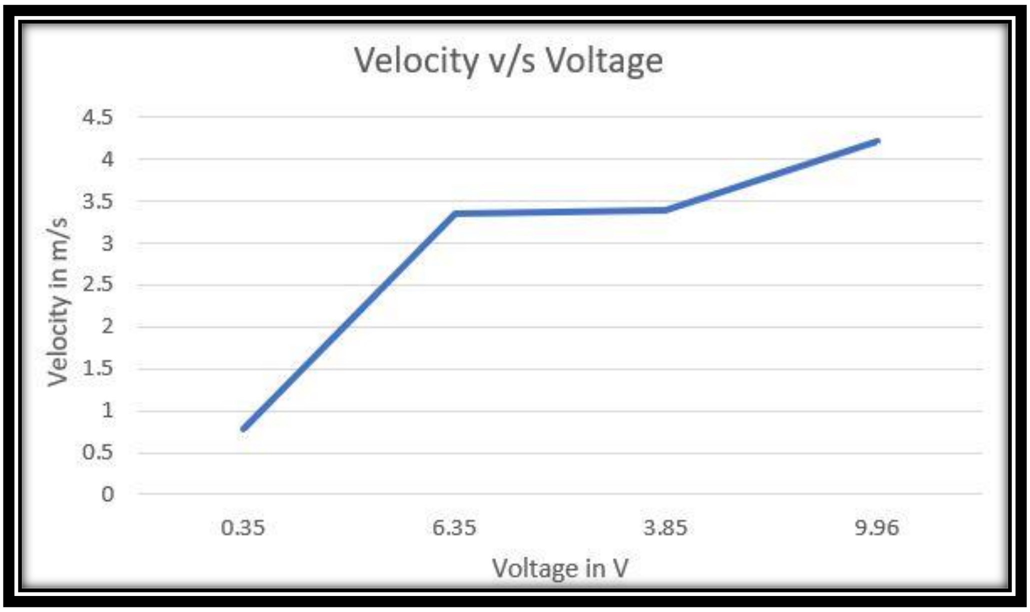

Figure 19 : voltage-velocity graph of lab experiment

4.2 Experiment conducted in Trapezoidal channel.

1. Width of channel: 1.27m
2. Overall depth of the channe(y): 1.11m
3. Slope of the channel: 1:1.5
4. Velocity = 0.25 m/sec
5. Head of water = 0.305m
6. Area of the channel: 5.106 m^2
7. Discharge Q = velocity x area

= 0.25 x 5.106

= 1.276 m^3/sec

TABLE 2: Representation of results of experiment conducted in trapezoidal channel

SLNO	Depth(y= overall depth of the water)	Depth in m	Velocity in m/sec $Velocity = \sqrt{\frac{2 \times ev \times 1 \cdot 602x \cdot 10^{-19}}{mass\ of\ water}}$	Voltage in v
1	0	0	0.94	0.5
2	0.2y	0.061	0.73	0.3
3	0.6y	0.183	0.377	0.08

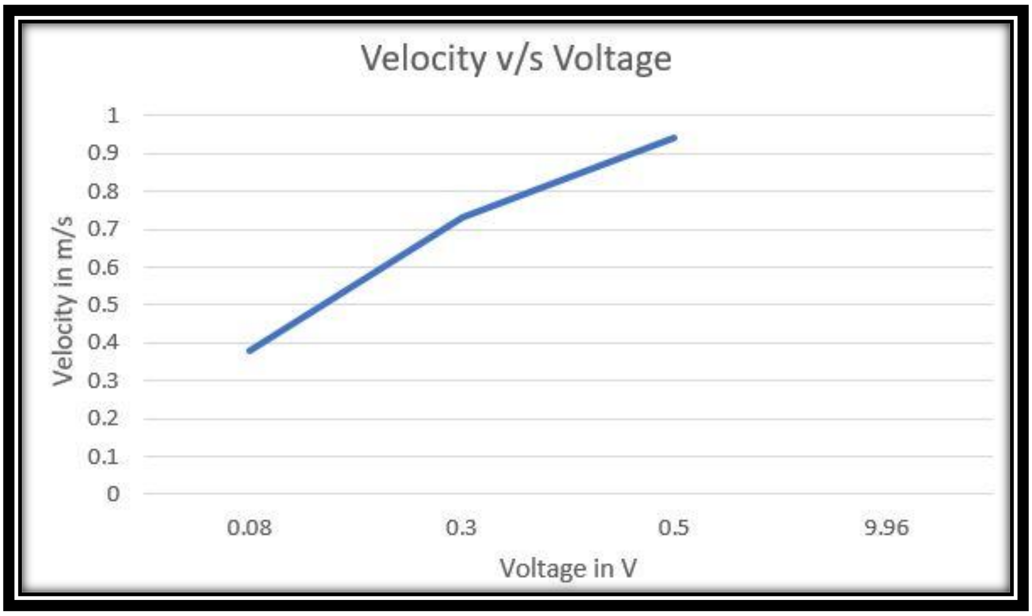

Figure20: voltage- velocity graph of trapezoidal channel

4.3 Experiment conducted in Hebbal river

Depth of water: 0.35m

TABLE 3: Representation of results of experiment conducted in Hebbal river branch

SLNO	Depth(y= overall depth of the channel)	Depth in m	Velocity in m/sec $\textit{Velocity} = \sqrt{\frac{2 \times ev \times 1 \cdot 602x \cdot 10^{-19}}{mass\ of\ water}}$	Voltage in v
1	0	0	1.116	0.7
2	0.2y	0.07	1.33	1
3	0.6y	0.21	0.94	0.5
4	0.8y	028	0.42	0.1

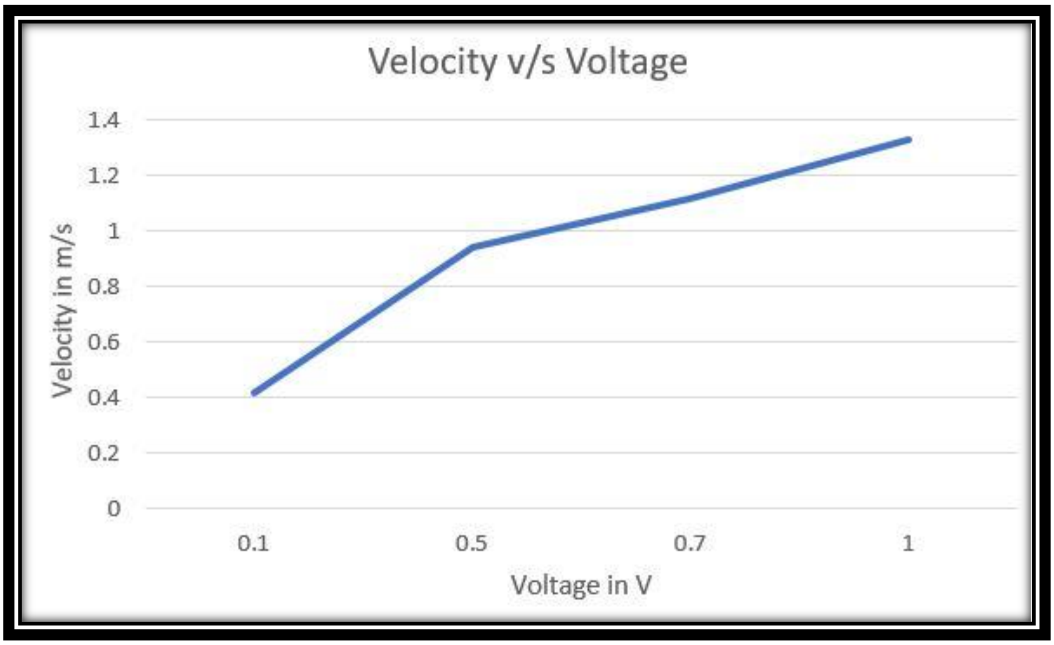

Figure 21: voltage – velocity graph of hebbal river

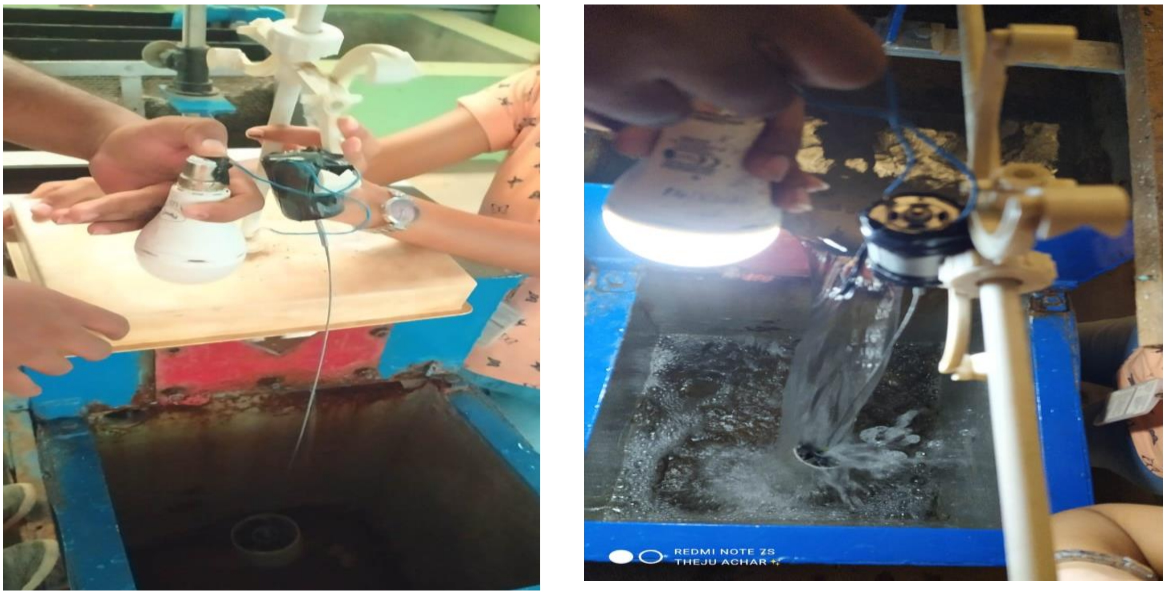

Figure 22 : maximum voltage obtained in FM laboratory (9.96V)

CONCLUSION:

The portable hydroelectric generator helps society to enjoy the environmental electricity with a low investment and as it not restricted to any class of the society each and everyone who are in need can be benefitted by this. Portable hydroelectric generator has proven itself as a major contributor to the electrification in developing countries. From the results it is proven that the velocity is directly proportional to the voltage that is been produced hence, it proves that the velocity distribution in a theoretical aspect is true i. e velocity in a 0.2 times of overall depth is maximum compared to any other depth. Finally, This low cost portable hydroelectric generator is sustainable and long-lasting source of energy which fulfill the emergency need of electricity.

INNOVATION IN THE PROJECT:

The innovative part of the project is to make use of the theoretical aspect of the velocity distribution in open channel flow to make the model effiecient one. The maximum velocity is observed at a depth 0.2 times of the overall depth of the channel, That is the voltage produced is directly proportional to the velocity, since the model is designed to place at depth where the velocity is maximum, the working efficiency of the model is achieved.

SCOPE OF FUTURE WORK:

The portable hydroelectric generator helps society to enjoy the environmental electricity with a low investment and as it not restricted to any class of the society each and everyone who are in need can be benefitted by this. Even it could change the lifestyle of people residing in remote areas. With the model we have generated maximum volts of 9.96V at a depth of 0.2y (0.104m) and could blow a 9V bulb with the further enhancement of the model one could able to generate much higher voltages and can be utilized for the other various work beyond the emergency requirements. Installation of this system at a depth of 0.2 times of overall depth of the channel is more efficient than installing at any other depths.

If this models are developed in a larger scale, society can be benefitted much more than we expect.