CHAPTER 1

1.1 Introduction to Pedal Operated Water Purifier

During the aftermath of floods in various states of India recently, the survivors didn't have enough of potable water to drink. A device to treat the water so that it is drinkable would be valuable for emergency situations like flood, hurricane, drought, etc. During distillation, water temperature is raised so that steam is formed. This steam can condense on a surface and be recollected. Only pure potable water remains because containment particles won't evaporate.

It can be even used in areas where electricity isn't available. Electricity at rural and remote areas is extremely erratic, thus making conventional water purifiers almost redundant for use. Thus, this project is specifically aimed at such areas and conditions of the world where water supply is erratic or non-existence and access to clean drinking water is sometimes at long distances. It not only provides potable drinking water but also provides healthy exercise.

Water purification is a process of removing the undesirable chemicals, biological contaminants, suspended solids and gases from water. A pedal operated water filtration system is a water filtering apparatus which can water by using human muscle power via pedal operated mechanism. It will be specially designed to perform two significant functions: storing water and filtering it as and when required. The aim of this project is to solve the problem of purifying drinking water by creating a durable apparatus which is cheap to manufacture and buy, which can last for a longer period of time in rural condition and which can be detachable so that it can be mounted on any frame, the assembly can be transported to a different location whenever required and finally it does not require any special skills to assemble or run the device.

The system works on the sprocket chain system with power generator dynamo along with supporting frame interfaced with a heating chamber which is integrated with a heating element. The overall apparatus is designed to be as lightweight as possible and as cheap as possible so as to make it easily accessible to a very wide range of people. The apparatus is also designed to be made detachable so that it can be shifted from one place to another with minimal modifications.

The pedal powered water purifier is a decent step towards helping people to get purified water without much sources. The pedal powered water purifier works mainly on mechanical

energy thus cutting down the need of electricity for the process of water filtration which make it more useful in the areas where electricity is a major issue. Pedalling is pollution free, thus it can be an eco-friendly system.

1.2 Water Purification Methodology

Some of the existing advanced water purification methods are RO purification, UF purification, UV purification or e-boiling, candle filter purification and activated carbon purification while some of the basic methods are distillation, boiling and desalination.

- RO Purification - Mechanical pressure is applied to an impure solution to force pure water through a semi-permeable membrane. Reverse osmosis is theoretically the most thorough method of large scale water purification available.

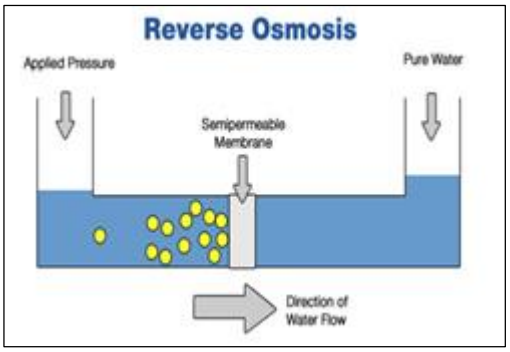


Fig 1.1

- UF Purification - Ultrafiltration (UF) is a membrane filtration process similar to Reverse Osmosis, using hydrostatic pressure to force water through a semi-permeable membrane.

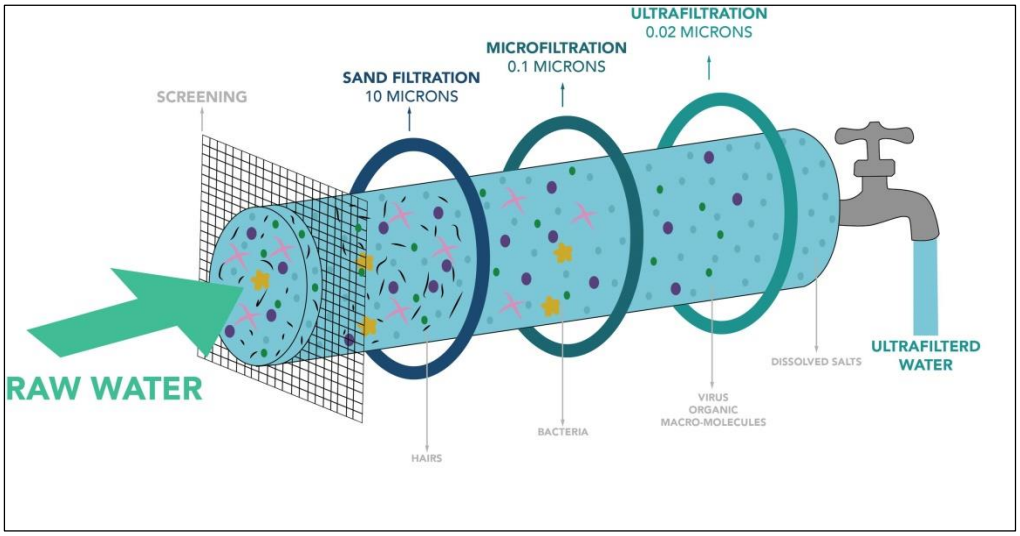


Fig 1.2

- UV Purification - Ultraviolet light (UV) is very effective at inactivating cysts, in low turbidity water. UV light's disinfection effectiveness decreases as turbidity increases, a result of the absorption, scattering, and shadowing caused by the suspended solids. The main disadvantage to the use of UV radiation is that, like ozone treatment, it leaves no residual disinfectant in the water; therefore, it is sometimes necessary to add a residual disinfectant after the primary disinfection process.

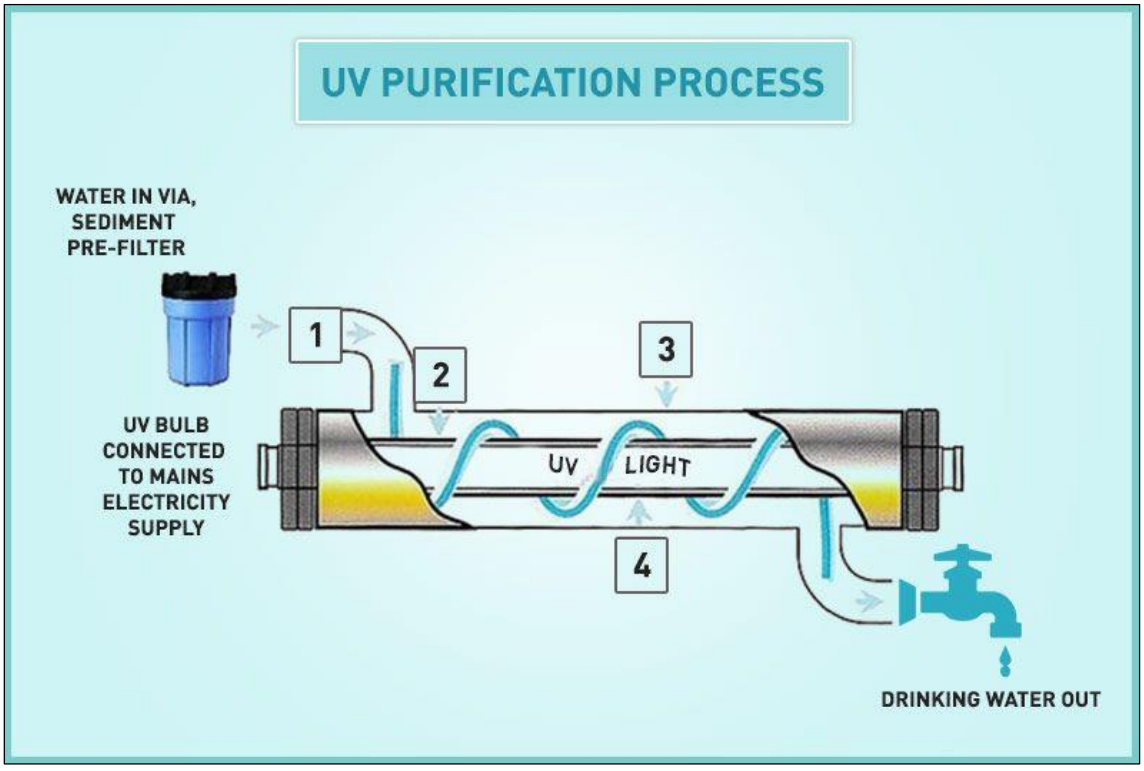


Fig 1.3

- Candle Filter Purification - Water purifiers with candle type filter have a very basic operating mechanism. The candle has very minute pores. Any particle which has the

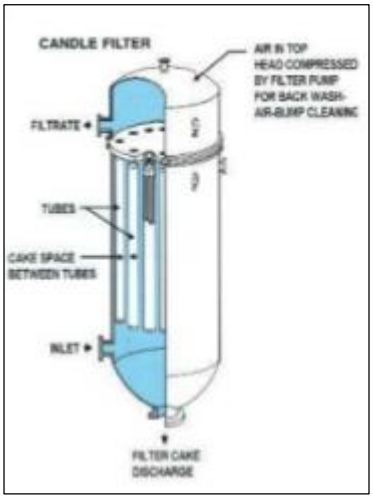


Fig 1.4

size larger than the pores gets blocked out and cannot pass on to the clean side. It does not require any electricity for operation. But the downside is that it fails to block microbes and so water still needs to be boiled before consumption. Also the candle needs to be cleaned up frequently for effective operations.

- Activated Carbon Purification - This water purifier use activated carbon filters for purification process. The carbon filters can remove chemicals like chlorine, pesticides and impurities to a great extent. The filtration changes the taste and odour of water. It does not require electricity for operation. But it is also not very effective in removing microbes from water.

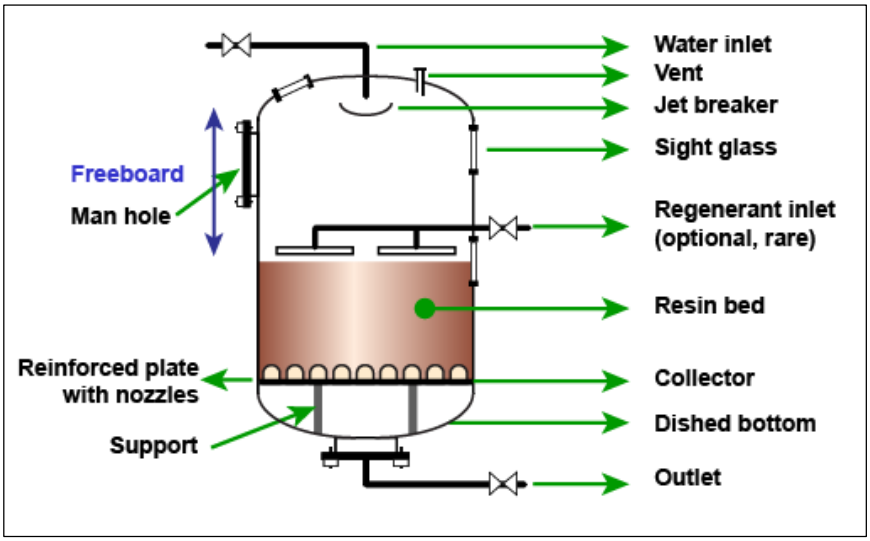


Fig 1.5

- Distillation - Distillation involves boiling the water to produce water vapour. The

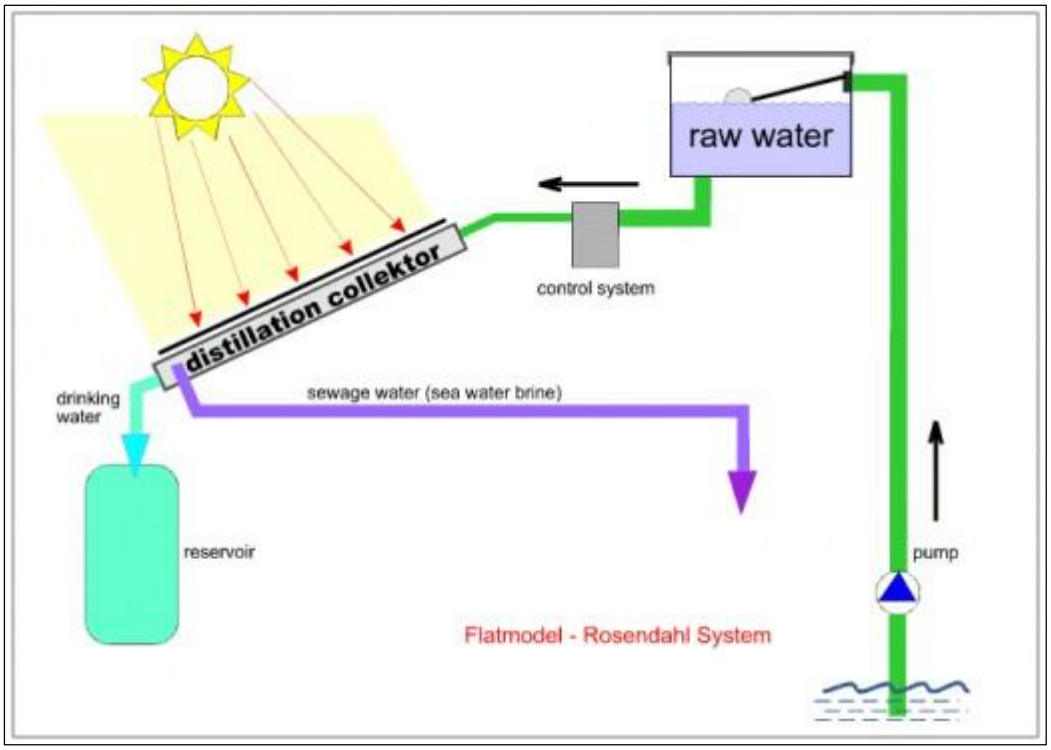


Fig 1.6

vapour contacts a cool surface where it condenses as a liquid. Because the solutes are not normally vaporised, they remain in the boiling solution.99.9% pure water can be obtained by distillation.

- Boiling - Bringing water to its boiling point (about 100 ℃ or 212 F at sea level), is the oldest and most effective way since it eliminates most microbes causing intestine related diseases, but it cannot remove chemical toxins or impurities. For human health, complete sterilization of water is not required, since the heat resistant microbes are not intestine affecting. The traditional advice of boiling water for ten minutes is mainly for additional safety, since microbes start getting eliminated at temperatures greater than 60 °C (140 °F). Though the boiling point decreases with increasing altitude, it is not enough to affect the disinfecting process.
- Desalination - It is a process by which saline water (generally sea water) is converted to fresh water. The most common desalination processes are distillation and reverse osmosis. Desalination is currently expensive compared to most alternative sources of water, and only a very small fraction of total human use is satisfied by desalination.

All these existing methods either require electricity or the power is obtained by the burning of fossil fuels. So such methods can't be used in places where electricity is not available or would be harmful to environment. The methods that do not require electricity or the power from the burning of fossil fuels don't have enough efficiency.

We are planning to make a Human Powered Water Purifier that can purify water at the greatest extent without the usage of electricity or fossil fuels.

1.3 Introduction to Product Development

The water is filled in the unclean water reservoir. The water is brought into the heating chamber for further processes. The flow of water is controlled by the control valve. As a person pedals, the power is given to the shaft on which a sprocket (that has a larger diameter) is mounted. The sprocket is connected to another sprocket (that has a smaller diameter) using a chain drive. The smaller sprocket has a wheel connected to it, which starts rotating as the sprocket rotates. The power from the wheel is transmitted to the DC permanent magnet motor by making contact between the rubber mounted on the shaft of motor and the wheel. As the shaft of motor rotates, it cuts the magnetic flux created by the permanent magnet. Due to this, induced current is generated in the conductor. The induced current is used to provide power to the electric heater. The electric heater starts heating up as the power builds up. The water in heating chamber, evaporates as the heating goes on. The water vapour rises and comes in contact with the unclean water reservoir which also acts as the condenser.

As the water condenses on the metal, the gravity pulls the water droplets along the swept surface of the cone until it reaches the tip. Upon reaching the tip, the water will fall down the outlet tube and into the clean water reservoir.

CHAPTER 2

Literature Review

We began researching existing water stills and found that the majority of the stills online were solar powered. These stills used the sun to heat a large surface area, which in turn, slowly evaporated the water. The evaporated water condensed on an inclined plane and dripped into a collecting basin. In order to utilize this method, we would have to replace the sunlight with human power. [2]

We also found that electrical stills could use up to 5000 Watts of power, producing approximately 6 litres of water per hour. Often, these units operated in a low-pressure chamber which lowers the boiling temperature. We compared this to that of a human pedalling full speed on an exercise bicycle and found it could only produce a maximum of 110 Watts. This discovery gives us a processing expectation of significantly lower than 6 litres of water per hour. [3] [4]

To better understand how we could use human power to transfer heat, we consulted both the Fundamentals of Thermodynamics [5] and the Principles of Heat Transfers books [6]. It was important to revisit the refrigeration cycle and the possible ways to transfer heat from one surface to the next. [7] [1]

We also visited and consulted with many stores and websites to explore other heating products and purchasing commercial products.

Also we reviewed other methods of purifying the water with different means. The method which came through were mostly the solar one which we mentioned above also there was one which included different levels of filtering the water through filters and the purification was carried on through that method

Also for fabrication of the project we researched for different methods of how to fabricate or manufacture it. We came across different methods and different research papers and review papers on internet and we studied each one of them and selected one of them

Some of the references are listed below:

Ademola Samuel Akinwonmi (2012) has prepared pedal power water purification and design was focused on process of conception, invention, visualization, calculation etc. he also made

a force analysis to check performance criteria. The physical parameter of design was determined by the appropriate calculation and the practical consideration with some reasonable assumption. It is discovered that the design is simple, cheap, efficient and affordable as could be seen from the readily available materials used. It also uses the Bernoulli's principle for the flow calculation with the help of peristaltic pump. [8]

Betzabe Gonzalez (2014) has studied on the design and he used peristaltic pump with silicone tubing. This tubing was visually better suited for our project having no kinds to reduce flow, easy to clean and flexible enough to create suction between rollers. Sidecar is added to the bicycle for the two tanks setup one of dirty water & other of clean water tank for utilization around the home. Filtered water we get through this design. [9]

Yuichi Katsuara (2011) president of Nippon basic company was the first company to give Portable Water Purifying System "Cycloclean" powered by pedalling bicycle to make 5 liter (max.) of clean water in a minute at a technology fair in Tokyo. It need man power to turn a bike chain driving motor to pump water through series of filter (without the use of electricity). Clean water can be utilized for domestic purpose. [10]

A. Peramanan (2014) has studied the fabrication of Human Power Reverse Osmosis Water Purification Process. The device use pedal to harms human motion to convert it into usable power to run a reverse osmosis filtration system. Osmosis is a natural process in which a liquid from a less concentrated solution flows through a semi permeable membrane to more concentrated solution. Reverse osmosis is an effective method of reducing the concentration of total dissolved solid sand many impurities found in water. The project has been carried out to make an impressing task in the field of water purification method. [11]

Jayant Gidwani (2016) has done the fabrication and experimental investigation of pedal powered water pump along with the purification system which is use for pure drinking water supply and garden irrigation purpose. The design has the working of centrifugal pump which is been operated by pedal power. [12]

CHAPTER 3

Problem Definition

The main reason to select this topic is to solve the filtration problem of water in calamities and in rural areas where there is no electricity or where there is fluctuation in supply of electricity.

After reading various journal papers we came to know that many attempts were made to solve this problem. Many of them were of human powered water purifier or human powered water pump which will suck the water from the ground and will pass the water through filters which will purify the water.

Mostly these concepts revolved around the use of a bicycle as the main component which will generate the power to do the pumping of the water and at the same time filtering the water.

The most common and basic method was to pump the water and pass through the filter so that water can be purified. But there were complications in this method as the power required to start the pump and run it on the constant power is very hard as there is always a little fluctuation in pedalling of a human. Also pump varies on its size, the pump required for these project will be more so as the cost of pump will increase the cost of the project so we decided to use a normal arrangement for supplying the water by supplying it directly into the container were the water is going to heat.

Fig 3.1

So we started referring the methods and finally decided to use motors to generate the electricity and use that electricity to heat the water. But there where different methods to generate the electricity through motors.

In some of the project the motor is coupled with the front sprocket of the cycle with the help of chain drive to transfer the motor. But in this special sprockets are to be made according to the size of the diameter of the shaft of the motor as well as the width of the teeth of the sprocket according to the chain size. This will lead to increase in the cost of the overall project so we found another method.

Fig 3.2

The method was to use belt drive to transfer the power. In this method the sprocket of the cycle is coupled with a pulley of the same size so that when the cycle is pedalled pulley starts to rotate as well. Then a belt is used to couple that pulley with the shaft of the motor but the problem in this method is that since the shaft of the motor is very small compared to the size of the pulley there are chances of slip of the belt which will lead to fluctuations in power generation. Also the size pulley to the size of the shaft cannot be changed as the power ratio will decrease and will lead to generation of less amount of power which will not be sufficient to heat the heater.

Fig 3.3

CHAPTER 4

4.1 Proposed Methodology

1. Replacing pump with motor

Some project used only pump as their main component and to supply water throughout the system. But pump as complications such as vibration, fluctuation in water supply also the main reason is its cost. As the cost increases with the size of the pump so if we want to supply more water in one cycle a large pump will required to do the same. If we use a small pump to supply large quantity of water it will take a large amount of time as well as lot pedalling to do the same. After having brain storming sessions within the group members we decided to supply the water directly into a compartment separate from the cycle and regulate flow of the water with the help of a flow control valve.

Accordingly, we came up with the idea of cancelling the use of pump and directly supplying the water. Instead of wasting the energy to run the pump we decided to use it in some other way. After consulting some journal papers as well as professors of college we came to the idea of using the pedalling energy to create the heat with some means. Then we came up with the idea of using a motor in a reverse manner. The basic working of a motor is when we supply power to the motor the motor's shaft starts rotating. Instead we will the rotate the shaft which will produce the electricity at the opposite end. This method was approved by the professor as well as other group members.

2 Motor placements for power generation

After deciding on using of motor the main challenge was to how and where to place the motor so that the shaft of motor runs at a very high rpm (revolution per minutes) and produces electricity so that electricity can be used for heating the motor in some way. There were many methods to rotate the shaft. All the methods previously used are mentioned in CHAPTER 3 "PROBLEM DEFINITION**"**. The method we choose and was the most convenient to use was to directly touch the shaft of the motor to the circumference of the rear wheel of the cycle. As the size of the wheel of cycle is very large and the size of the motor is small in comparison to the wheel the speed ratio is also very high and it will help us to achieve the target of electricity to be produced to enable the heating of the water. First we

taught to use a large shaft whose one end will be connected to the rear wheel of the cycle and on the other end there will be another wheel of cycle and the motor will be connected to that the wheel. But if use this idea the size of the project will increase and it will no longer be a portable device which will lead to a disadvantage.

So we decided to directly make an arrangement for the motor to come in contact with the wheel. After brain storming we came to the conclusion of mounting the motor on the cycle in such a way that the motor's shaft will be in contact with the wheel. A frame was decided to be manufactured for the mounting of the motor. In this way the mounting of the motor was decided.

3 Use of Heater

Now that the generation of electricity was finalised, now the main objective was how to use that electricity to heat the water. In a research paper we came across the idea of using a nichrome wire for heating as the it's thermal conductivity is more in comparison to any other substances. But the main problem for using nichrome wire was safety concern as there was no means for protection to the user. To increase the safety we would have to use some insulation material to cover the wire. But by adding the insulation there were some chances that the nichrome wire would lose its thermal conductivity or it will reduce the same.

So after surveying on internet we came to know that a portable heater is available in market which was made of the same material that is nichrome and also there were no safety related issues as it was insulated beforehand. Also it is compact and small in size so it was very handy and can be fit in any place so there were no issues in placing it or making any separated arrangement for the same.

4.2 Design

4.2.1 Unclean Water Reservoir

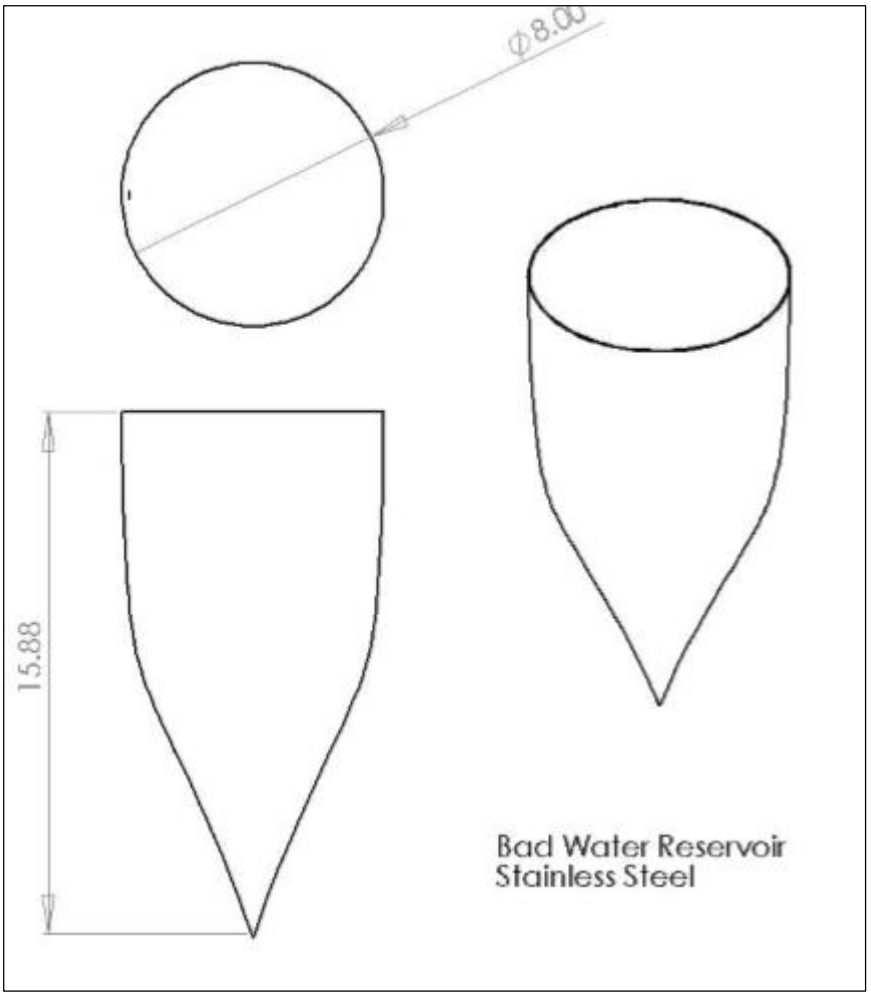


Fig – 4.1

4.2.2 Insulation Metal Tube

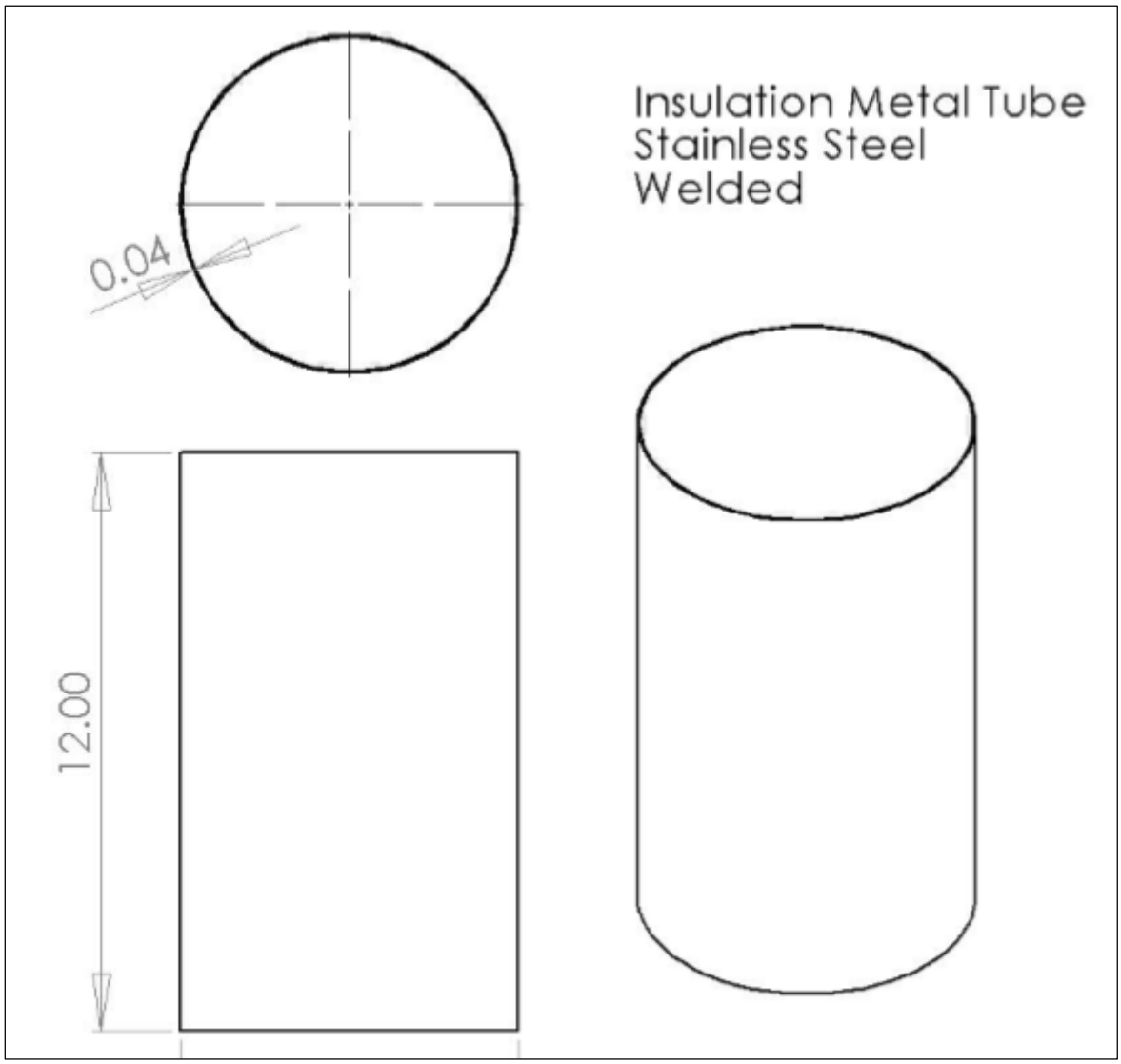


Fig – 4.2

4.2.3 Heating Cup

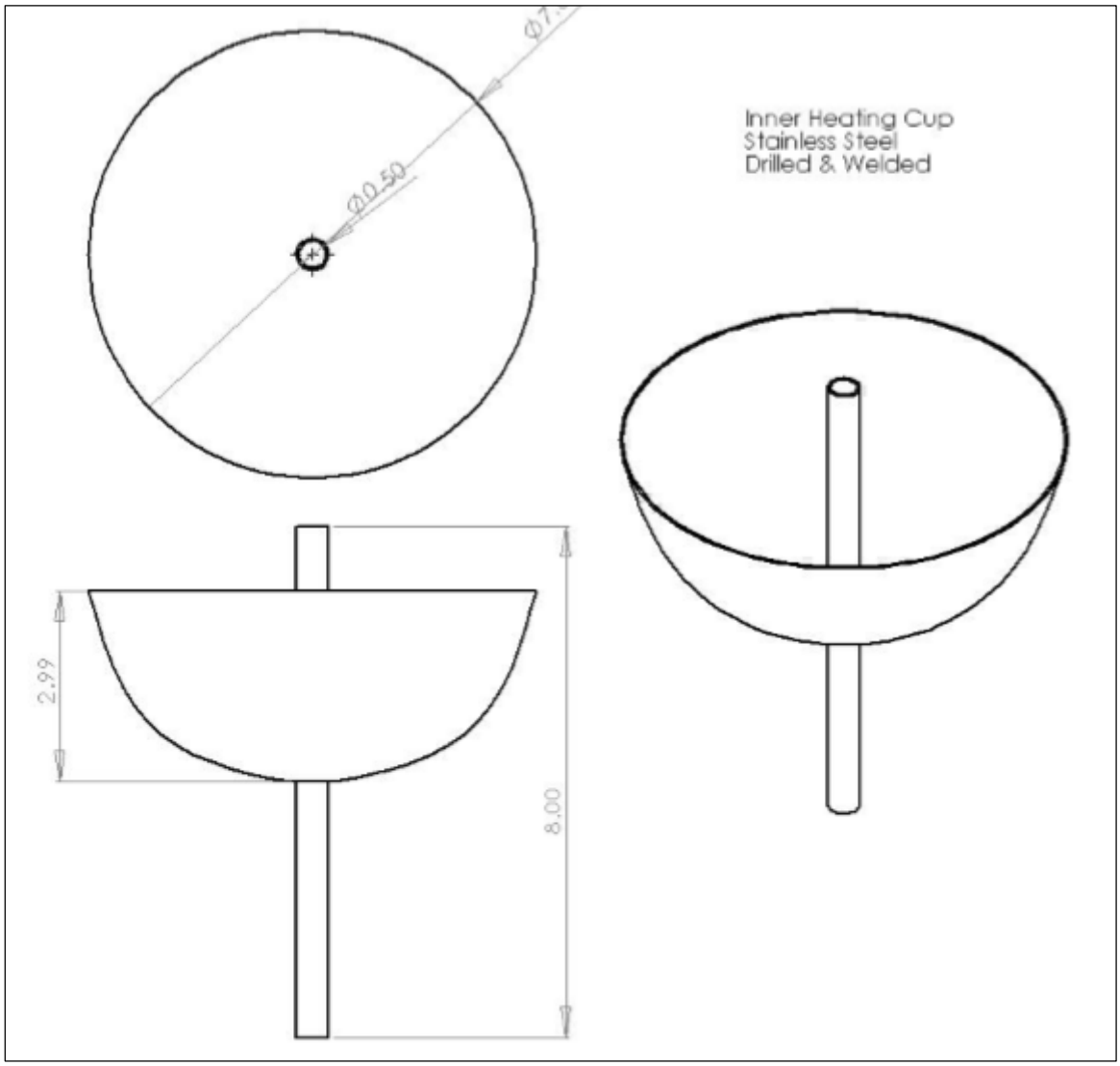


Fig – 4.3

4.2.4 Pipe and Fittings

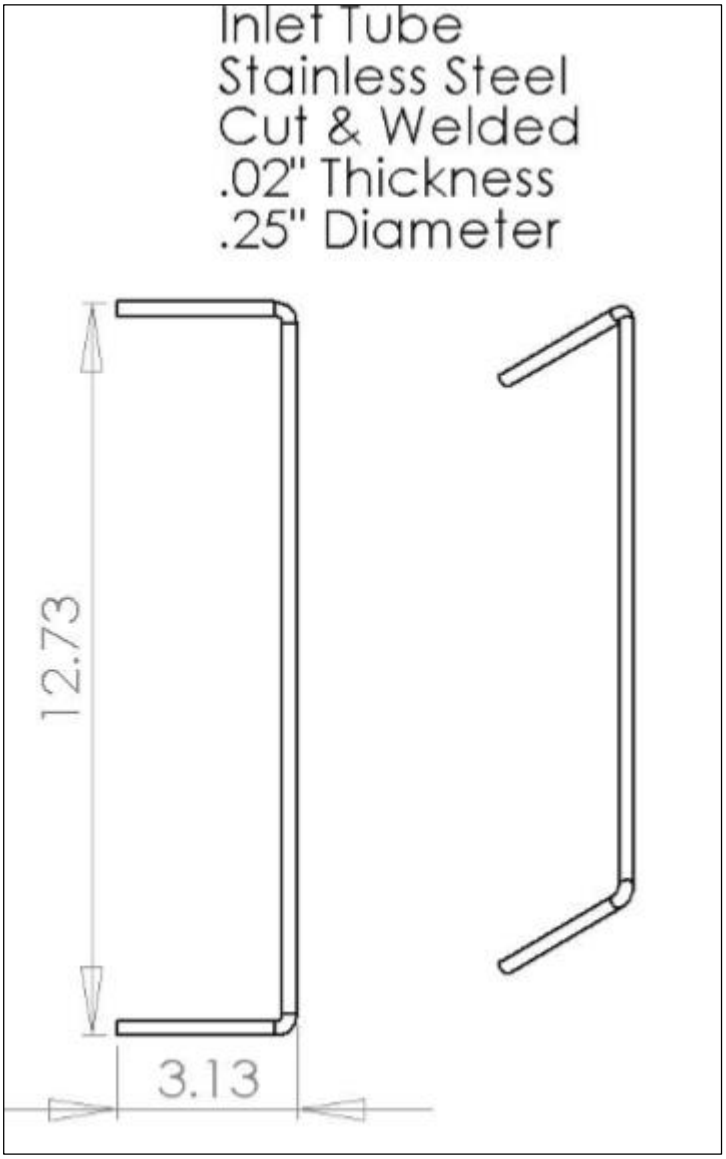


Fig – 4.4

4.2.5 Collection Chamber

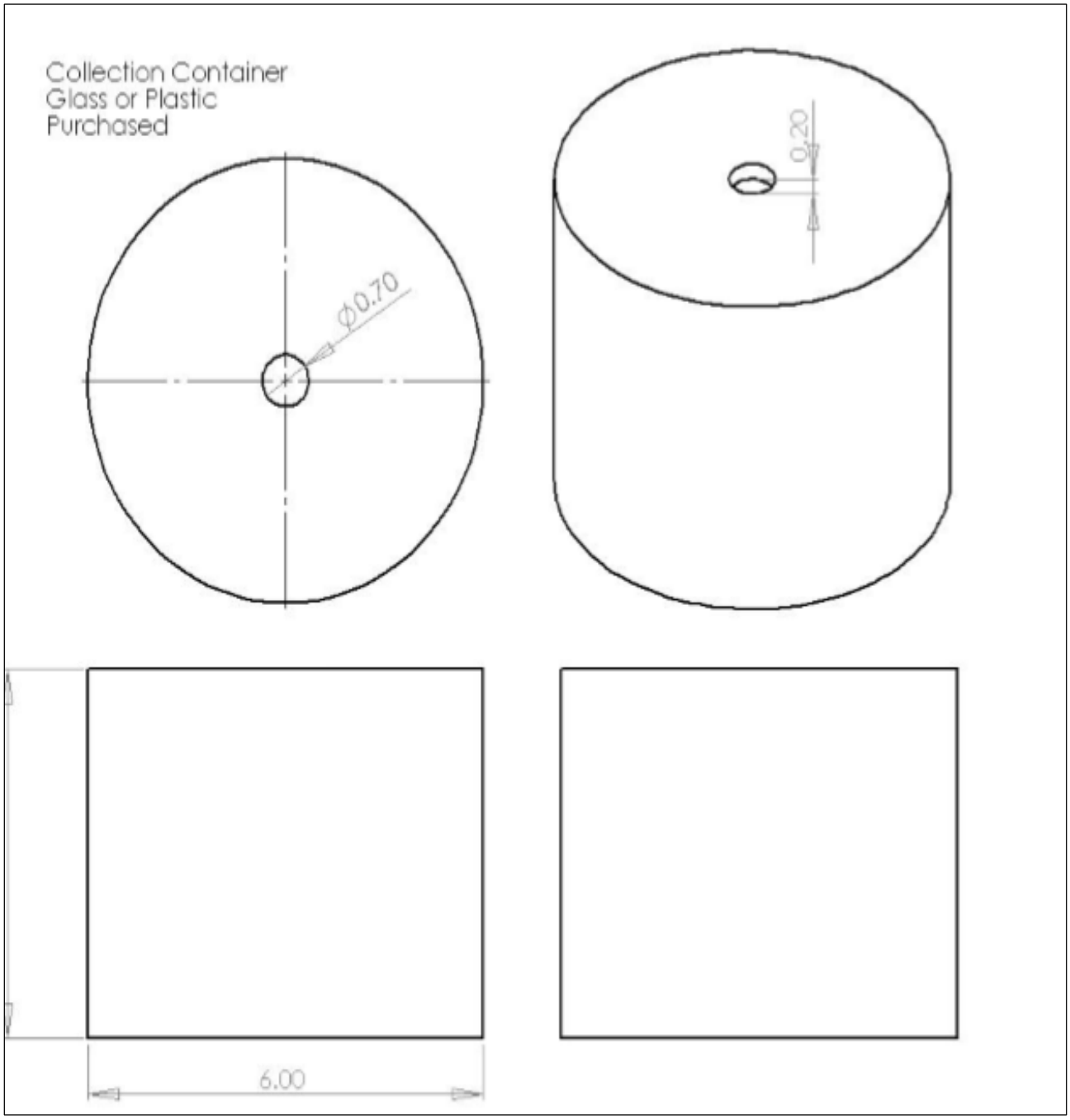
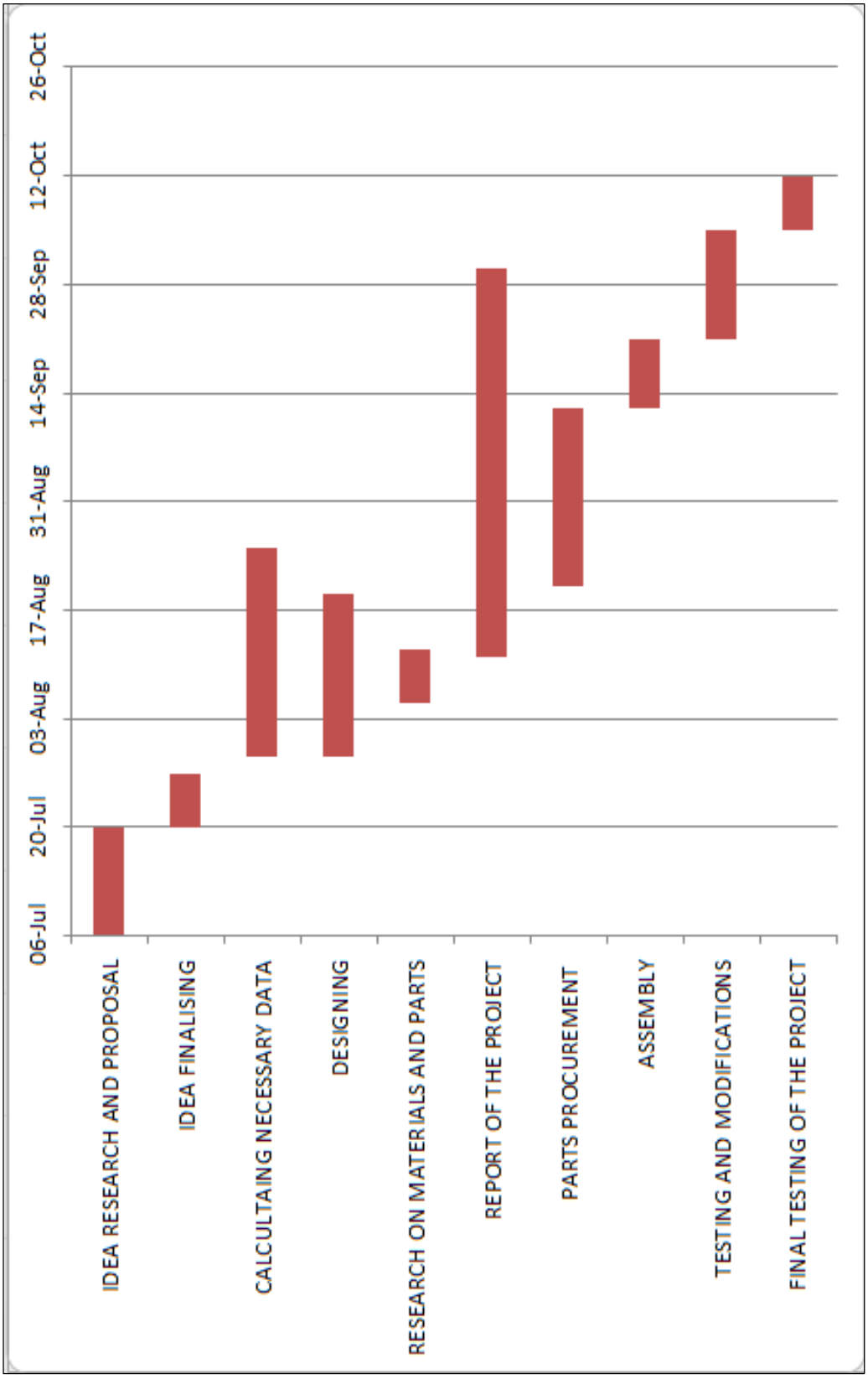


Fig – 4.5

4.3 Activity Plan

Table No- 4.1



CHAPTER 5

5.1Components Used

5.1.1 Unclean Water Reservoir

The main objective of the unclean water reservoir was to act as a storage are9a of unclean water and as a condenser. The unclean water reservoir was made up of stainless steel sheet. The sheet used for the manufacturing had a thickness of 1mm. It was manufactured in two different parts. The two different parts were 1) the cylinder and 2) the cone. The cone shape

Fig –5.1

was made to fulfil the function of condenser. The reason for making the reservoir in two parts was that it would have become complicated to make it together. So we had decided to make it differently. Both the cylinder and cone were manufactured by the process of rolling. The ends were later welded together to form a complete joint. The cone and cylinder were later welded together. The unclean water reservoir required a hole to be drilled on the side for the pipe.

5.1.2 Insulation Metal Tube

The objective of the insulation metal tube is to contain the heat inside the tube. The metal tube was made up of stainless steel sheet of 1mm thickness. Stainless steel

Fig – 5.2

was selected as the material had to withstand a high temperature and would be in contact with water vapour. The sheet was rolled into a cylinder shape and the ends were welded. It had been provided with a hole on the side for pipe. The water that would be coming through the pipe from the unclean water reservoir. The water that would enter from the hole would be collected in next component i.e. the heating cup. The insulation metal tube is placed under the unclean water reservoir.

5.1.3 Heating Cup

The objective of heating cup is to heat the water. The water that comes through the pipe to insulation metal tube is stored in this heating cup. Due to time constraint, we were not able to manufacture the heating cup. So we had bought it from a dealer.

Fig – 5.3

5.1.4 Heater

The objective of the electric heater is to heat the water up to appropriate temperature (i.e. boiling point of water). The reason to heat until the boiling point of water is reached is that the amount of water stored in the heating cup is completely evaporated. The heater works on 230V AC. The power consumed by the heater is 180Watts.

Fig 5.4

5.1.5 Pedal Assembly

The objective of this assembly is to produce mechanical energy which would be later converted into electrical energy later on. It consists of pedals, sprockets, chain and a wheel. There are two sprockets, one of smaller diameter and other has a larger diameter. The chain is mounted on the sprockets. The pedals are attached to the larger sprocket, while the wheel is attached to the smaller sprocket. As the pedal is moved by a human, the smaller sprocket rotates. The movement of larger sprocket causes the chain to move ahead. At the smaller sprocket end, the chain would move backwards. Due to this the smaller sprocket will also rotate. As the wheel is attached to the smaller sprocket, it will also start rotating

Fig – 5.5

5.1.6 Permanent Magnet DC Motor

The DC motor is used to act as a dynamo. The shaft of the motor has a piece of rubber attached to it. The motor is placed so as the rubber attached to the shaft of motor comes in contact with the wheel and the shaft is parallel to the axis of rotation of wheel. As the wheel rotates, the piece of rubber will also rotate. Hence, the shaft of motor will also rotate. The rotation of shaft cuts the magnetic flux. Therefore, induced current will be produced in the conductor (i.e. the wire through which the power is supplied to the motor). The reason for using a permanent magnet DC motor is that if we would have used an electro-magnet magnet, some amount of current would be required to power up the magnet. Therefore, our device won't be able to be used at places where electricity isn't available. The motor can produce around 24 V approximately and generate 180W of power.

Fig 5.6

5.1.7 Pipe and Fittings

The pipe and fittings are used for basic purpose of transporting water from one part to another. The material for pipes and fittings is unplasticized polyvinyl chloride (uPVC). We have used uPVC as the pipe would be in contact with heat which the PVC can't withstand. The fittings used are elbows and a flow control valve. The elbow is used to turn the pipe at 90˚.While the flow control valve is used to maintain the flow of water. As the amount of water that can be heated at a time is limited, the quantity of water going into the heating chamber needs to be controlled. Hence, a flow control valve is used.

Fig 5.7

Fig 5.8

Fig 5.9

5.1.8 Collection Chamber

The only objective of collection chamber is to collect the clean water. The material used for collection chamber is plastic. There are not so many requirement of the collection chamber as it is not in contact with heat. The only requirement of the collection chamber is it should be safe to store the potable water. Hence, we would be using food-grade plastic container.

Fig 5.10

5.2 Construction

We started the construction of our device by purchasing a bicycle. An arrangement was attached to the bicycle so that the rear wheel of bicycle didn't made contact with the ground when the cycle is pedalled. If the rear wheel made contact with ground, it would move forward and we don't need it to move forward. While we are pedalling the cycle, we just need the rear wheel to rotate as the motor would be in contact with the wheel. The motor has to be placed in such way that the shaft of the motor is parallel to the axis of rotation of the wheel. As we were using two motors, both the motors were placed such that they are parallel to the axis of rotation and the motors receive support from the frame of bicycle.

Simultaneously, while a part of team was assembling the bicycle, the other part of team was assembling the remaining part of the device. First, the stainless steel sheet was purchased according to our requirement. The stainless steel sheet was then given to the manufacturer to be manufactured as per our designs which have been showed above. The products made out of the sheet were two cylinders and a cone. All the three were made using rolling and later on were welded together. One of the cylinders which has the diameter same as that of the cone is welded with the cone to form the unclean water reservoir. The unclean water reservoir is placed on the reservoir (i.e. the insulation metal tube). Once the unclean water reservoir is placed accordingly, the insulation metal tube is covered with insulation fibreglass foam to increase the efficiency and safety. The wires of the motor were connected to the heater

5.3.1 Working

The purification of the water is done by the human power. So, the human will be sitting on the chair to drive the pedal which will generate electric power to purify the water. When the pedal is operated first the bigger sprocket will start to rotate which will drive the smaller sprocket by means of a chain drive. On the smaller sprocket a shaft will be made to pass which will be connected to a wheel of an bicycle. The smaller sprocket will drive the wheel as the pedal will be operated. When the wheel will start to rotate their will be an small permanent magnet DC motor which will be meshing with the wheel. Here the part of mechanical energy will be converted into electrical energy. The motor will be driven by the wheel where the shaft of the motor will start to rotate. As the shaft of motor rotates, it cuts the magnetic flux created by the permanent magnet. Due to this, induced current is generated in the conductor. The current generated here will be passed to an heating element which will placed in an heating chamber.

The main body will be placed at some distance form heat generating system. In the body the purification of water will be carried out. The unclean water will be stored in an unclean water reservoir which is to be purified. Slowly this uncleaned water will be passed to heating chamber for purification by means of a branch pipe. This branch pipe will be made to pass through the outside of the body with the help of elbows and fittings. There will be an small ball valve of which will pass the water partially when it is opened. This water is directly passed to the heating chamber.

Inside the heating chamber the actual heating process will be carried out which will purify the water. The heating coil will be placed inside the heating chamber which will purify the boil the water. In this heating chamber the electrical energy will be converted into thermal energy for boiling purpose. The boiling action will purify the water which will be used for drinking.

The boiled water will start to evaporate and the steam will start to move upwards because of the boiling action. This evaporated steam will go and strike the cone shaped part. At this point the steam will start to cool down slowly and will become purified water. Because of the shape of the cone all the water will start to move and will get concentrated at the tip point of the cone. Then drop by drop this water will start to move down and will be made to pass through a steel pipe.

Inside the steel pipe the temperature of the water will drop down more and will be completely ready for drinking. From the pipe the purified water will be collected in an water collection chamber. This collected water can then be used for drinking purpose.

5.3.2 Connection of Motor and Heater

Fig 5.11

Connection of heater and motor is the most important connection as this is the mai part of the whole project. So it was important to mention it in the report

The red terminal of motor is connected to one of the terminal of heater and the black terminal of the motor is connected to the other terminal of the heater. The connection can also be reversed as the heater does not need a specific connection. The connection be done in any method.

CHAPTER 6

6.1 Testing

Our testing of project was based on trial and error method. We started the testing of the project by connecting a single motor to the heater. The power generated by the motor was not enough for the heater to be heated. The reason for this was instability of motor (that is the motor wasn't stable due the vibration created). As we were not able to determine real cause behind the loss of power generation we tried to test it with two motors. Even though we used two motors, we were not able to acquire the amount of power we needed to heat the heater. After consulting our professor, we came to know that the power generation was not stable as the shaft of the motor was not rotating at the constant speed. We tested the two motors with the help of a temporary support. Even after that we were not able to produce enough power to heat the heater. So we consulted our professor again. Then we came to a conclusion that power generated by one of motor was consumed by another motor and hence, the shaft of another motor was rotating. Since, the power was getting consumed by the motor, the heater was not getting heated.

So we reversed the wiring. After that we tested it and came to a conclusion that the heater was getting heated. It was not feasible and economical to use two motors as the cost of supports was increasing. Hence, diverting us from our basic aim to make a cheap water purifier. So we tried to use single motor and proper support. We were able to generate enough power to heat the heater. As we the heater got heated, we tried to put it in the water.

As we put the heater in water, the heater was getting cool down. So we consulted our professors. They said that the water would absorb the heat during the start. So we tried to heat the heater for a longer duration of time while in water. Even though we heated it for a long period of time, the water wasn't getting heated until the limit we needed. After discussing among the group we got some suggestions that we should try to conceal the heat in a particular region. So we made an insulation tube so that the heat does not escape from the tube and remains in it for some period of time. We tested again. The amount of heat generated was enough but took a lot of time to be generated.

So we came to conclusion that the heat should be absorbed by the tube. Hence, the heat would remain in the tube for a longer period of time. After that we concluded that, for the heat to be absorbed by the tube we have to paint it in black. We tested the heating again and were successful in producing the amount of heat required to evaporate the water.

So we assembled the device and tried to purify the coloured water. But we were not able to get the purified water in the clean water container. So we dissembled the whole device and tried to find the fault. We found out that the condensed water was not falling in the pipe provided to collect the condensed water. It was falling around the pipe. Hence, it was getting collected in heating chamber again.

We concluded that water should fall in the pipe directly. Hence, we started to think about an arrangement that could be provided to collect the water. We got a suggestion that we could use a funnel. We tried testing using a funnel and were able to do it.

We did the final testing with 2L of water with food colouring in the unclean water reservoir. Temperatures of the heating chamber was recorded to monitor if the water was getting heated. After around 45-50 minutes, we were able to produce purified water.

CHAPTER 7

7.1 Conclusions

We know that electricity is still one of the major problems in rural areas. In summer days people struggles with the shortage of water, pedal powered water pumping and purification system meet these problem as this system only works on pedal operated by the human power. There is no need of electricity neither to pump the required amount of water nor to purify the dirty water by using electricity or by burning the fossil fuels. This system is free from pollution and does not cause any harmful effects.

This type of system will be very helpful for people in rural areas. The system will cost a reliable price which can be affordable and will take very less amount of maintenance. The system will give a large amount of exercise to the person pedalling the bicycle. It will not require any sort of external electricity supply or any other power to operate.

The pedal operated water purifier will be able to purify the water which will be used for drinking purposes. The system can purify the water of river, pond, lakes etc. It can also purify the water with some small amount of chemical pollutants. This system will be very helpful in places were natural calamities has been occurred. It can give the purified water within a short period of time. The amount of time for the purification of water will differ from person to person.

The benefits associated with access to safe drinking water provide a strong argument to increase resource allocations to interventions aimed at further improving the current drinking water situation, as a key entry point for achieving much wider livelihood benefits. The pedal operated water purifier system is a new system that is useful in developing countries like India to have daily access to safe drinking water all by harnessing the energy of pedal power.

7. Cost Estimation

Table no-7.1

Serial no.	Name of the component	Cost
1.	Sheet metal	700
2.	Dc motors	2800
3.	Immersion heater	100
4.	Cycle	1400
5.	Pipes and fittings	115
6.	Machining and finishing	1750
7.	Miscellaneous	500
	Total	7365

7.3 Advantages

- The main advantage of this system is that no electricity is used
- Major use in hilly areas and also in remote or village areas where there is no facility of permanent electricity
- In this system there are no gases produced so there is minimal pollution caused
- As pollution caused is less, global warming is also reduced
- Also due to provision of battery in this system when there is no purification process going on the energy produced can be stored in battery
- As the purification process is carried out with the help of only mechanical power there is no fire needed so burning of wood is also not done

7.4 Disadvantages

- The main disadvantage is that it needs man power for functioning of the process
- Due to the need of man power, the process cannot be done for longer period of time
- The purification time can vary from person to person so it is not constant for everyone

7.5 Future Scope

This type of project can be very helpful in developing countries like India. It can solve the daily crisis of water in rural areas. This project has a wide scope in future. It can go for purifying large amount of water in shorter time. A large amount of water can be purified by increasing the capacity of the tank to store the water. With the help of various other mechanical means input to output ratio can be increased. It means that at minimal input a large amount of water can be purified.

A belt and pulley assembly can also be used to transmit the power form pedal to heating chamber. The shaft of the bigger sprocket can be made to pass through the pulley and the power can be transmitted.

For heating purpose nichrome wire can used instead of the heating coil. Nichrome wire will help to increase the efficiency for heating purpose. It will probably take much lesser time to heat the water. Otherwise two heating coils can also be used by increasing the size of the heating chamber.

A battery can also be used to store the energy. The energy generated by the operation of pedal can be stored in battery. This stored energy can be used in future purification purposes. Whenever the human is free he/she can pedal the bicycle can generate the electricity and store it in a battery. The circular force of the pedal can be transmitted to a dynamo. The power generated by the dynamo can be stored in battery and can be used whenever needed.

Instead of the heating chamber a filter can be used to purify the water. This filter can get the electricity with the help of pedal and chain and electricity can be transmitted with the help of a dynamo. This whole system can be fitted on a bicycle so that it can be portable.

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