BICYCLE DRIVEN WATER PURIFICATION SYSTEM

MINI PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this project report titled "**BICYCLE DRIVEN WATER PURIFICATION SYSTEM"** is the bonafide work of **KALAIVANI B (111720102051)** who carried out the work under my supervision.

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ABSTRACT

Water is a natural resource essential for life and for most economic activities developed on earth. The availability of drinking water is essential for the survival all of mankind. Lack of clean drinking water in rural areas is a huge problem during the occurrences of floods and other environmental disasters.Often, it takes a long time to transport potable water to these areas resulting in health issues to the local residents. It lacks formal water supply systems and the population is forced to consume untreated water directly from rivers without treatment. Moreover, water purification is essential especially in time of calamities.
During calamities many people will require mass amounts of clean water.
In the rural areas of developing countries, boiling is the means most often used for purifying water for food preparation and drinking. Waterborne pathogens in developing countries cause several billion cases of disease and up to 10 million deaths each year, at least half of which are children.The idea is to purify the water using low cost, manually driven bicycle power water purifier.This concept brings in a solution for the drinking water problems in the rural areas.

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LIST OF ABBREVIATIONS

- **RO -** Reverse Osmosis
- **BIS -** Bureau of Indian Standards
- **TDS -** Total Dissolved Salts
- **BDWPS -** Bicycle Driven Water Purification System

CHAPTER 1

1. Introduction

1.1. Problem Statement

"Necessity is the mother of invention"

And day by day, our necessities keep increasing exponentially. One such important necessity is water. Though many inventions have been made, still, the problem hasn't came to an end. The available water resource is also quite scarce and not all people are accessible to clean water supply. Also the available water is not free of contaminants and impurities, that consuming those unclean supply causes various diseases and affects our health. The inventions made by scientists are very much advanced and solves the crisis but they are pretty much expensive. Poor people from rural areas can't afford to buy such costlier equipments which require lots of energy for their use. Ignoring all these facts, we can also use boiling as a technique to purify water. This requires substantial use of fossil fuels and that contributes to depletion of forests.

1.2. Objective of the project

This project helps us get a solution to the water scarcity problem. It ensures that the dirty and impure water can be reused once treated. It makes them free of all the impurities and water-borne pathogens that brings about harmful side effects to our immune system. Also, this system is cheap and inexpensive that it is easily affordable by people. And, this requires no fuel to initiate its working. So, there will be no cutting of trees that leads to forest depletion.

1.3. Project Scope

The controversial problem of availability of clean and safe drinking water can be brought to the finish line using the bicycle driven water purification system. The setup of this system is quite simple. The main source of this system is the bicycle. Impure water is treated using this system and we get clean drinking water that is safe to be consumed.

1.4. Water purification

Water purification, process by which undesired chemical compounds, organic and inorganic materials, and biological contaminants are removed from water. The purification procedure reduces the concentration of contaminants such as suspended particles, parasites, bacteria, algae, viruses, and fungi. There are various techniques involved to purify water. All these methods in figure (fig 1.) in one way or the other purifies the impure water and makes it free of the impurities. Some are conventional methods which require no financial output. But the rest of the methods are expensive and advanced.

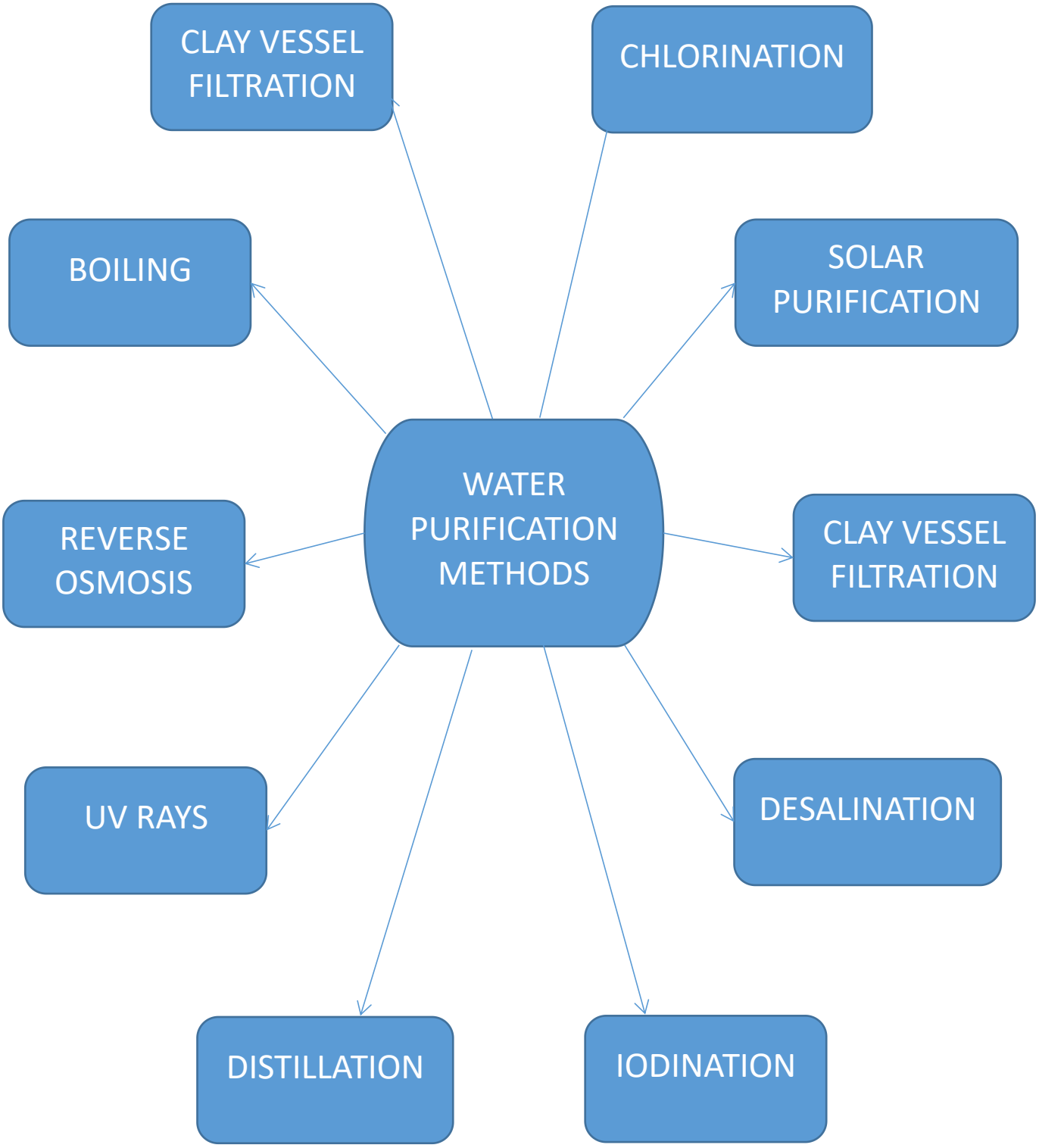

Fig.1. Different types of water purification methods

1.5. Reverse osmosis

Reverse osmosis (RO) is a water purification process that uses a partially permeable membrane to separate ions, unwanted molecules and larger particles from drinking water. It works by using a high pressure pump to increase the pressure on the salt side of the RO and force the water across the

semi-permeable RO membrane, leaving almost all (around 95% to 99%) of dissolved salts behind in the reject stream. The purifier used in this system follows this RO process. The RO system has a pore size of approximately 0.0001 micron. This process has an effective role in removing viruses.

1.6. TDS meter

According to the Bureau of Indian Standards (BIS), the Total Dissolved Salts (TDS) is the total concentration of dissolved substances in the drinking water. It helps to precisely identify the place from which we get water. Also, water is a universal solvent and easily picks up impurities and can absorb and dissolve them quickly. Elevated TDS in water changes the taste of water. We measure TDS to identify the taste, health concern and cooking use.\

Table 1: TDS level and desirability

TDS LEVEL	DESIRABILITY
50-150	Excellent for drinking
150-250	Good
250-300	Fair
300-500	Poor
Above	Not fit for use

CHAPTER 2

2. System Implementation

2.1. System specification

The requirements of this project are

- Bicycle
- Centrifugal pump
- Hinge
- Purifier
- Tubes
- Containers
- TDS meter

2.2. Component description

Bicycle

It is the main equipment of the system. It acts as the initiator for the purification process to take place. The operator has to drive the pedals through which the system gets operated.

Centrifugal pump

Once the pedals are driven, the Tyre of the bicycle gets rotated. This in turn rotates the impeller of the pump which sucks in impure water and sends it to the purifier.

Hinge

This is used to keep the motor attached to the back seat of the bicycle. It makes sure that the motor remains intact with the cycle despite all the movements created.

Purifier

The most important part of the system is the purifier. As the name suggests, it performs the cleansing action of the water and makes it free from impurities and the water is now ready for usage.

Tubes

Water is transported throughout the entire system using tubes. Initially, the impure water is sucked in and sent to the purifier upon the activation of the motor. After the process of purification, clean water is sent out through the tubes set.

Containers

They are used to store the water that is to be treated. Impure water is first kept in one of the containers to be purified. After purification, clean water is stored in another container for use.

TDS meter

The TDS meter plays an important role in conforming that the given water is desirable for drinking or not. The water which is treated using the bicycle driven water purification system is verified using the TDS meter.

CHAPTER 3

3. Existing systems

3.1. Pedal powered water pumping

This paper presents fabrication and experimentally investigate the working of Pedal Powered Water Pump (PPWP) along with its purification which had used for pure drinking water supply and garden irrigation. PPWP will consist of a centrifugal pump operated by pedal power. The centrifugal pump is positioned on its stand in such a way that driven shaft of the centrifugal pump was butted to the bicycle wheel. By pedaling the bicycle, the bicycle wheel rotates, thereby rotating the centrifugal pump which in turns discharges water from the sump. PPWP provides drinking water and irrigation in remote areas where electricity is not available. PPWP is not only free from pollution but also provide healthy exercise. PPWP reduces the rising energy costs. PPWP will design as a portable one which can be use for irrigation in various places. The experimental investigation was execute and performance of the PPWP had carried out at different rpm. The results indicate that the PPWP will give a considerable amount of discharge and head. The PPWP requires only manual power thereby reducing the utility bill considerably. Experimental result shows that discharge of about 0.0025m can be obtained for around 140rpm.

3.2. Reverse Osmosis by cycling action

Pure water is very much essential to survive, but now a days the water is getting contaminated due to Industrialization which leads to many water-related diseases. Reverse Osmosis(RO) Water Purification by Cycling Action meets the needs of people without requiring any electrical energy. RO is a physical process that uses the osmosis phenomenon, that is, the osmotic pressure difference between the salt water and the pure water to remove the salts from water. Water will pass through the membrane, when the applied pressure is higher than the osmotic pressure, while salt is retained. As a result, a low salt concentration permeate stream is obtained and a concentrated brine remains at the feed side. A typical RO system consists of four major subsystem : pre - treatment system, high-pressure pump, membrane module and post treatment system. In operation by pedaling the cycle, man power is converted into mechanical energy which is further converted into hydraulic energy in RO pump

CHAPTER 4

4. Literature review

Irjet Pratik s. Nagrare et al 2017 [1] proposed a pedal powered purified water supply device. It works on the principle of compression and sudden release of a tube by creating negative pressure in the tube and this vacuum created draws water from the sump into the pump while rollers push the water through to the filter where adsorption takes place to purify the water. This paper proposes to take on challenges associated with the accessibility and cleanliness of water in developing countries by designing and building a filtration system and sidecar that are portable, durable, and cost-effective.

Vishal Garg, Neelesh Khandare et al 2013 [2]. In this paper author mentioned Ademola Samuel Akinwonmi et. al 2012 [3] have conducted a experiment on 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 use the Bernoulli's principle for the flow calculation with the help of peristaltic pump.

Yuichi katsuara et. al 2011 [4]president of Nippon basic company was the first company to give Portable Water Purifying System "Cycloclean" powered by pedaling 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.

Peramanan et. al 2014 [5] 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. Betzabe Gonzalez et. al 2014 [6] has analyzed and 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.

M venkata praveen kumar et al 2017 [7], given his idea on purification of water by bicycle to harness human motion to convert it into usable power to run a reverse

osmosis filtration system. The flow rate was determined according to given information from the reverse osmosis manufacturer.

Anusha Pikle, Yash Siriah et al 2017 [8], gave a paper which analyzes the design of a pedal operated water filtration system to be used by local dwellers. It works on the principle of compression and sudden release of a tube by creating negative pressure in the tube and this vacuum created draws water from the sump into the pump while rollers push the water through to the filter where adsorption takes place to purify the water.

Anand and ramprasad et al 2017 [9], reviewed the literature regarding a variety of portable water purification techniques like boiling, solar water disinfection, sedimentation and ceramic filters coagulation, adsorption (activated carbon), chlorination, uv irradiation, ultra filtration, reverse osmosis and other combined methods that have been predominantly used at the household level.

Jayant Gidwani et al 2016 [10], In this paper author mentioned about fan pump (ppwp) along with its purification which has been used for pure drinking water supply and garden irrigation. PPWP will consist of a centrifugal pump operated by pedal power. The centrifugal pump is positioned on its stand in such a way that driven shaft of the centrifugal pump was butted to the bicycle wheel. PPWP provides drinking water lubrication of ppwp. And experimentally investigates the working of pedal powered water and irrigation in remote areas where electricity is not available.

Garud and kulkarni 2017 [11], gave a paper in which reverse osmosis (RO) is a membrane based process technology to purify water by separating the dissolved solids from feed stream resulting in permeate and reject stream for a wide range of applications in domestic as well as industrial applications. It is seen from literature review that ro technology is used to remove dissolved solids, color, organic contaminants, and nitrate from feed stream. Hence RO technology used in the treatment of water and hazardous waste, separation processes in the food, beverage and paper industry, as well as recovery of organic and inorganic materials from chemical processes as an alternative method . This paper intends to provide an overall vision of RO technology as an alternative method for treating waste water in different industrial applications.

Mogaji p. B. Et al 2016 [12] has analyzed & studied the development of an improved pedal powered water pump, can be used for irrigation and drinking water purposes. It is more productive operated pumping system and is time saving. The system is composed of a reciprocating pump powered by pedaling. The pedal power is being transmitted to the pump via a chain drive.

Eric Harshfield, Ana Jemec Et al 2009 [13] gave a paper on Water Purification in Rural South Africa The authors present the design and constructed process for a slow sand filtration system intended to provide clean drinking water to most households in the community. The paper ends with a reflection examining aspects of engineering community engagement projects including site assessments prior to project implementation, project timeframes, and crosscultural institutional collaborations.

Sonal P. Thomas, Noble Patrick K. Et al 2014 [14] has analyzed on Pedal Powered Centrifugal Pump. The objective of the is paper was to design, fabricate and experimentally investigate die working of Pedal Powered Centrifugal Pump (PPCP)

which used in small drinking water supply and garden irrigation. PPCP consists of a centrifugal pump operated by pedal power. The centrifugal pump is positioned on its stand in such a way that driven shaft of the centrifugal pump is butted to the bicycle wheel. The experimental investigation was executed and performance of the PPCP was carried out at different rpm. The results indicate that the PPCP had given a considerable amount of discharge and head. The PPWP requires only manual power thereby reducing the utility bill considerably. Experimental result shows that discharge of about 0.0025m /sec. It can be obtained for around 140rpm.

M. Jayamoorthy, B. Sridhar et al 2017 [15] mentioned about the Purification system of water by cycling pedaling is useful in purifying the water by means of a cycle operated with reverse osmosis process. It includes the cycle pedal being rotated and inlet being connected to the membrane of the reverse osmosis setup. It is used to increase the discharge level of the water involved in purification. Hence the amount of water used can be purified and used by these means of purification with a lots of water borne diseases. This method is used inproviding he purified water that can be available for all people in a very low cost.

M. Jawahar, G. Venkanna Et al 2014 [16] discussed the mechanism of Pedal Operated Centrifugal Pump for Low-lift Applications rare wheel of the bicycle is rotated with the help of driver and driven gear of the bicycle. The chain drive of the centrifugal pump is connected to the rare wheel hub of the bicycle, it also rotates when the rare wheel of the bicycle is rotated with the help of the rotation system. The shaft of the centrifugal pump rotates up to 3700rpm.With the rotation of the great speed the vacuum is created in the centrifugal pump and this vacuum in this centrifugal pump suck the water from the water tank and it discharge the water through outlet with some amount of pressure.

Sreejith K., Martin O.J. Et al 2014 [17] reviewed on design, fabricate and experimentally investigate the working of Pedal Powered Centrifugal Pump (PPCP) which used in small drinking water supply and garden irrigation. PPCP consists of a centrifugal pump operated by pedal power. The centrifugal pump is positioned on its stand in such a way that driven shaft of the centrifugal pump is butted to the bicyclewheel. By pedaling the bicycle, the bicycle wheel rotates, thereby rotating the centrifugal pump which in turns discharges water from the sump. PPCP provides drinking water and irrigation in remote areas where electricity is not available. PPCP is not only free from pollution but also provide healthy exercise. PPCP reduces the rising energy costs. PPCP is designed as a portable one which can be used for irrigation in various places. The experimental investigation was executed and performance of the PPCP was carried out at different rpm.

Dustin Drake, Michael Solley Et al 2011 [18] discovered whether human powered reverse osmosis is a viable option for producing potable water for developing countries. The matters at hand are to determine whether human power is enough to operate such a system, how much clean drinking water it will produce, and device was designed to test the practicality of this idea through a numerical analysis. The device uses a bicycle to harness human motion to convert it into usable power to run a reverse osmosis filtration system. This was used to calculate the power needed to power such a design and was then compared with researched data of available power from humans. It indicated that a human could easily provide enough power to run a reverse osmosis system such as this. The flow rate was then used to determine how

useful this power was by considering how fast it could produce clean drinking water and how much water a person needs to drink daily.

Anyanwu, S. Ikechukwu Et al 2016 [19] mentioned that the design was originally conceived to meet the energy needs of those living in rural areas, due to poor access to electricity and also as a model for gym centers and cycle workout studios. Most persons living in these rural areas possess at least a cell phone but lack the means to charge them. This study focused on the design and fabrication of a pedal operated power generator, for the intents of burning fats while yet generating electricity. The power generator was designed to be simple, cheap, durable and easily maintained. It was fabricated using locally sourced materials and is intended to encourage local ingenuity and empower aspiring entrepreneurs especially in developing countries. Its purpose is to efficiently transfer human foot motion less than 60 rpm via a treadle and sprocket-chain step-up to drive a 24V DC permanent magnet generator. The inverter converts the direct current (DC) into alternating current (AC) which is needed to charge low voltage devices like mobile phones, laptops etc.

Dhruv Duggal Et al [20] 2014 reviewed the design and construction of bicycle operated pump filter is explained which is used in irrigation and filtration at small scale.

CHAPTER 5

5. Methodology

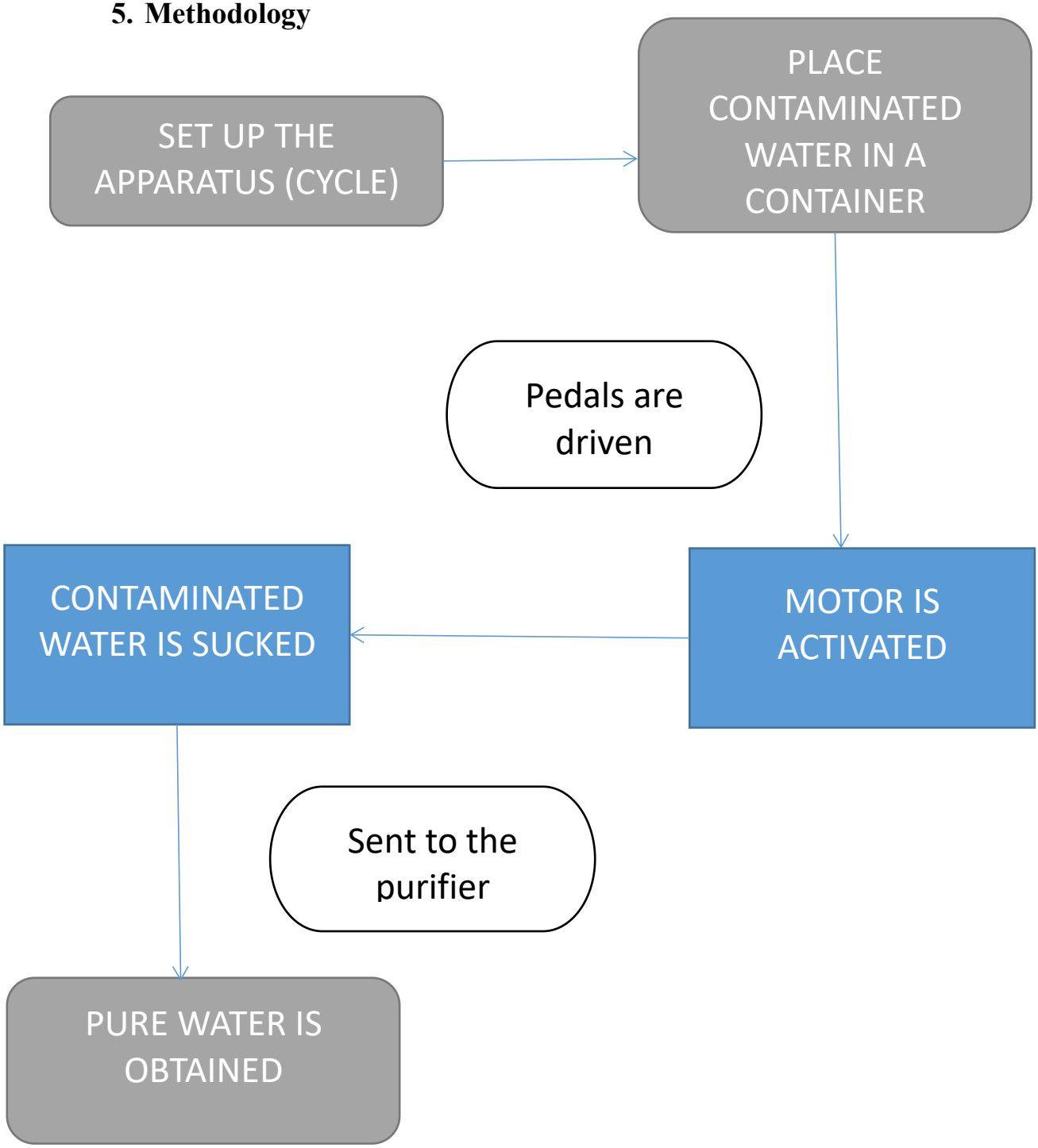

Fig.2. Block diagram of bicycle driven water purification system

CHAPTER 6

6. Diagram

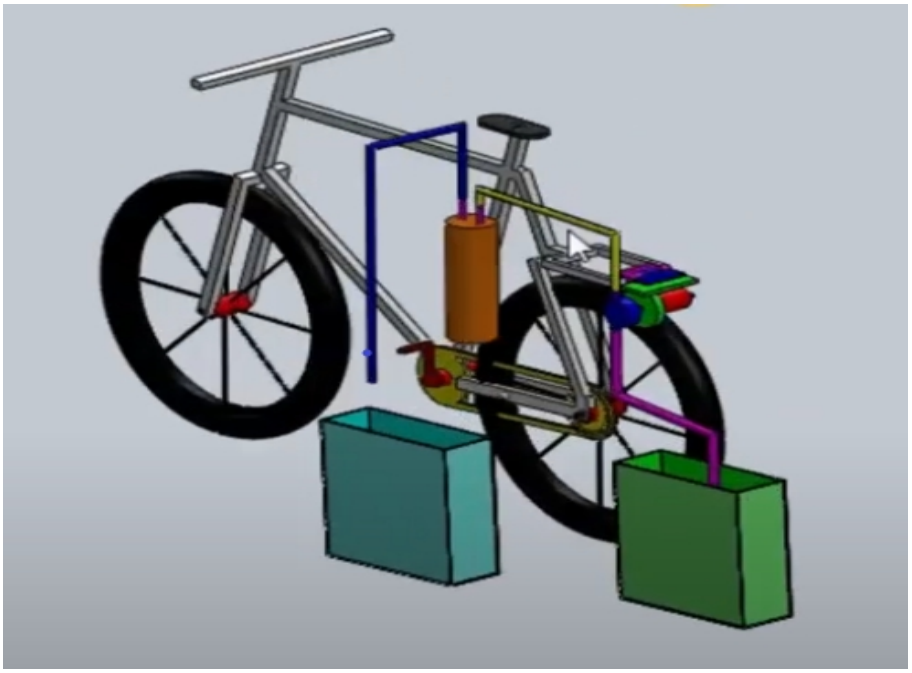

Fig.3. Bicycle driven water purification system 3D model

Place contaminated water in a container. Set the apparatus ready. Once pedals are driven, the rotational motion of the Tyre makes the rotor of the pump to rotate. This rotation of the pump sucks in contaminated water through the tubes and sends it to the purifier. The purifier purifies the dirty water and sends out clean water that is apt for drinking and other uses.

Fig.4. Original setup

CHAPTER 7

7. Output

The water which is initially dirty is made clean once treated with the bicycle driven water purification system. The purification is done by the RO set that makes the water free of contaminants and impurities. It further removes the bcteria, protozoa and viruses that causes harmful health defects. Furthermore, it offers a high level of defense ensuring that the water is safe for use.

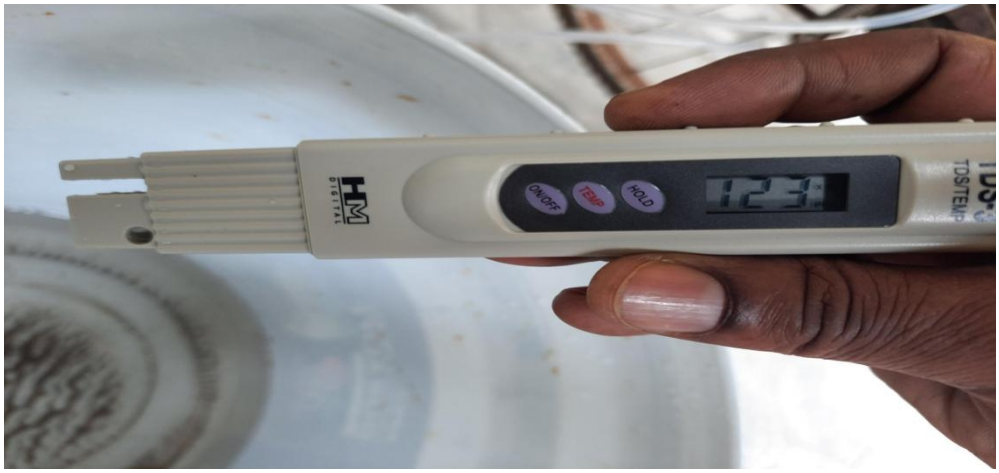

Fig.5. TDS reading of impure water

Fig.6. TDS reading of pure water after treatment from the BDWPS

CHAPTER 8

8. Results and discussion

8.1. Advantages

- This mechanism is well suitable in the rural areas.
- Electricity is not needed.
- One person can handle and operate the system.
- Saves time.
- The setup is quite easy that it can be easily attached and detached.
- The bicycle can also be used for other purposes.
- Cost efficient.
- Less maintenance.
- Can be used at times of natural calamities like flood, hurricane, etc.

CHAPTER 9

9. Conclusion

This research developed a novel way to turn unclean water into a purified drinking water. This system is useful especially during calamities where electricity is nonexistent and clean water is scarce. To ensure a hygienic living environment for residents in the remote areas, availability of clean fresh water is one of the primary needs, which is now possible using bicycle driven water purifier.

Remote areas usually lack basic clean water services. Considering low population, poor geographical accessibility and lack of electricity, a small-scaled water treatment system capable of producing clean fresh water , which is characterized with low capital cost, easy operation and less need of maintenance, is employed in the techno-economic study. An effort has been made to create a portable water purification system that cleanses water. Also, availability of fresh water at times of calamities is a big question mark. This system brings solution even to that problem also because it can convert flood water into clean drinking water an area affected in the calamity.

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