DEVELOPMENT ENGINEERING PROJECT (CP301)

END-SEMESTER REPORT

WATER PURIFICATION USING A PEDAL SYSTEM

DATE OF SUBMISSION: 10/05/23

SUBMITTED BY

GROUP NO.: - 14

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Table of contents

Certificate

This is to certify that the B. Tech project titled "Water purification using pedal system" prepared by (Aditya, Ashish, Hritik, Pratham, and Sourabh) is approved for submission for the course on Development Engineering Project (CP301) in the Department of Mechanical Engineering, Indian Institute of Technology, Ropar.

Signature of Examiner and Guide

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Declaration

I hereby declare that the report entitled "Water Purification using the pedal system" submitted by the group for the fulfillment of the course on Development Engineering Project (CP301) in the third year of the B. Tech program in IIT, Ropar. We carried out the work under the supervision of Dr. Harpreet Singh, Dr. Navaneeth K.M., and Dr. Dhiraj K. Mahajan, Department of Mechanical Engineering. We further declare that this written submission represents our ideas, and others' ideas or words have been included. We also have adequately cited and referenced the original sources in the case of others' ideas or words. We have not misrepresented any idea/data/fact/source to the best of our knowledge. Therefore, we affirm that our group has adhered to all academic honesty and integrity principles.

Place: IIT Ropar
Date: 10/05/2023

Signature of the Candidates

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Acknowledgment

We would like to thank and offer our heartfelt gratitude to our supervisor, Prof. Harpreet Singh sir for their continued support and guidance in helping us with our project successfully. Without their guidance, we would not have been able to make progress till now in this project successfully. We would also like to express our sincere thanks to our course coordinator Dr. Navaneeth K.M. for managing this course efficiently & various people and researchers whose research works helped us and extended the growth of our ideas. Also, we would like to thank our mechanical batch mates, who in some way or the other helped us in many ways. Thanks to each and every person who is contributing to the progress of this project, we, as a team, had a great time making the reports and presentation with the grace of the almighty, and hope this will continue in the future also.

Signature of the Candidates

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Abstract

The project "Water Purification using Pedal System" is a novel approach to providing safe and clean drinking water to rural communities where access to electricity is limited or non-existent. The project uses a pedal system to convert mechanical energy into electrical energy through a dynamo. The energy produced is then stored in a battery, which powers a water-purifying unit containing a booster pump and filters.

This project aims to design a low-cost and eco-friendly solution that can provide clean drinking water to rural communities, especially those living in areas with contaminated water sources. The proposed solution is easy to operate and maintain and can be powered by human energy.

The project comprises several components: a pedal system, dynamo, battery, booster pump, and filters. The pedal system is designed to be user-friendly, allowing individuals to generate electricity by pedaling. The dynamo converts the mechanical energy generated by the pedal system into electrical energy stored in a battery.

The water purifying unit consists of a booster pump, which increases the water pressure, and filters that remove impurities from the water. The water is first passed through a sediment filter to remove large particles, then through a carbon filter to remove odors and tastes. Finally, the water is passed through a reverse osmosis filter to remove impurities such as bacteria, viruses, and dissolved solids.

The project aims to provide an efficient and reliable solution for water purification that can be operated and maintained by individuals with minimal training. Using a pedal system as a power source reduces the cost of operation, making it a sustainable solution for rural communities.

The project has several benefits, including providing clean and safe drinking water to rural communities, reducing the spread of waterborne diseases, and improving health outcomes. Additionally, the project has a positive environmental impact, as it reduces the use of fossil fuels for power generation.

Chapter: 1

1.1. Introduction

Water is an essential resource for all living beings on Earth. However, access to clean and safe drinking water is a major challenge in many parts of the world. Lack of access to clean water can spread waterborne diseases, causing sickness and even death. This is particularly true in developing countries where the infrastructure and resources required for water treatment and distribution often need to be improved.

Our project aims to create a water purification system that can provide clean and safe drinking water cost-effectively and sustainably. The proposed system uses a pedal-powered mechanism to drive a water purification unit, allowing it to be used in areas without access to electricity.

The pedal-powered water purification system pumps contaminated water through a series of filters, including activated carbon and reverse osmosis membranes, which remove impurities, bacteria, and viruses. The system is designed to be operated by one or two individuals who can pedal the system to generate the power required for the water purification process.

The advantage of this system is that it is sustainable and does not require electricity or fossil fuels to operate, making it ideal for use in remote and underprivileged areas. The system is also portable and can be easily transported to different locations, providing access to clean water in areas most needed.

Finally, we can say our project aims to develop a water purification system that is cost-effective, sustainable, and accessible to communities in need. Using a pedal-powered mechanism, we hope to provide a solution that can be easily replicated and scaled, ultimately improving the quality of life for people worldwide.

1.2. Problem Description

Water is essential for human survival, but unfortunately, not all water sources are safe for consumption. Unpurified water can contain harmful impurities and contaminants, leading to severe health issues, including life-threatening diseases like cholera and typhoid fever. Access to safe and clean drinking water is a major challenge in many parts of the world, particularly in developing countries like India.

Fig.1: Polluted Waters: The Environmental Crisis We Can't Ignore

In India, inadequate access to safe water leads to the death of approximately 200,000 individuals annually. Furthermore, it is predicted that nearly 600 million people in India may face water scarcity issues by 2030. This issue is exacerbated by some areas' need for infrastructure, more resources, and better sanitation.

We propose implementing water purification using pedal systems to address the need for safe and clean drinking water. Pedal-powered water purification systems offer a low-cost, sustainable, and portable means of treating water in areas with limited or no access to electricity. These systems can improve public health by reducing waterborne diseases and enhancing the quality of life for individuals in these communities.

Recent reports in May 2021 indicate that 30 out of 33 districts in Punjab state of India are facing a severe groundwater crisis due to overexploitation and contamination of water resources. This situation highlights the importance of sustainable and efficient water management practices, including water purification methods like the pedal system, to ensure access to safe and clean water for domestic and

agricultural use.

In conclusion, access to safe and clean drinking water is crucial for human health and well-being. Water purification using pedal systems offers a potential solution to address the challenge of inadequate access to safe water, particularly in areas with limited or no access to electricity. By implementing this system, we can help improve public health, reduce waterborne diseases, and enhance the quality of life for individuals in these communities.

1.3. Objective/Aim

The objective/aim of our project is to develop a water purification system that can provide clean and safe drinking water cost-effectively and sustainably, using a pedal-powered mechanism. The following are the specific objectives of our project:

1. **To design a water purification system that is affordable and can be easily replicated:** One of the critical objectives of our project is to develop a water purification system that is cost-effective and can be easily replicated. This will ensure the system is accessible to needy communities, particularly in underprivileged and remote areas.
2. **To develop a sustainable and environmentally friendly system:** Another objective of our project is to develop a sustainable and environmentally friendly system. Using a pedal-powered mechanism, we can avoid using fossil fuels or electricity, reducing our carbon footprint and promoting sustainable development.
3. **To ensure that the water purification system is effective and safe:** Our project aims to develop a water purification system that effectively removes impurities, bacteria, and viruses from contaminated water. The system should be able to produce clean and safe drinking water that meets the required standards and guidelines.
4. **To promote community participation and empowerment:** Our project aims to promote community participation and empowerment. By involving local communities in the design and implementation of the system, we can ensure that the system is tailored to their specific needs and requirements. This will also help to build local capacity and promote sustainability.
5. **To solve the global water crisis:** Our project aims to solve the global water crisis by developing a cost-effective, sustainable, and accessible water purification system. By providing access to clean and safe drinking water, we can help improve the health and well-being of millions of people worldwide.

Our project aims to develop a pedal-powered water purification system that is affordable, sustainable, effective, safe, and accessible to needy communities. By achieving these objectives, we can help to address the global water crisis and promote sustainable development.

Chapter: 2

2.1 Literature review

1. **PEDAL POWERED WATER PURIFICATION:**

   In this study, to purify contaminated water they used Bernoulli's principle. The project comprises three stages: the Generator, Boiler, and Condenser. A chain drive transmits mechanical energy from the driver shaft to the pump, which draws contaminated water to the boiler. The generator then provides the input to heat the water in the boiler, turning it into vapor, which is then cooled and condensed in the condenser. The clean water is stored in a container for later use. The project is cost-effective, environmentally friendly, and can provide access to safe drinking water to villages in developing countries. (page no. 23[13])

2. **Pedal-operated water filtration system (Mobifilt):**

   This study aims to design a mechanism to supply purified water to village Pedal-operated laces by harnessing human pedal power. A peristaltic pump powered by paddling, a carbon filter, and a hose are used in the design. The pump creates a vacuum to pull the liquid into the tube, which is then forced through a filter that removes chemicals, pollutants, turbidity, and other microorganisms. Finally, the water is made drinkable using UV powered by a battery charged by a dynamo or solar panel. The peristaltic pump is made of mild steel to prevent corrosion. Mathematical modeling is used to determine the physical variables of the system.(page no. 22[12])

3. **Pedal Powered Water Filtration Systema:**

   This study involves the design of a pedal-powered water purifier for rural areas. The system uses a peristaltic pump, a filter, and a flexible tube to purify water through adsorption. The pump is powered by pedaling, creating a vacuum to draw water through the filter. The system is cost-effective, user-friendly, and produces no pollution. It can provide clean drinking water without the need for electricity. (page no. 22[11])

4. **WATER FILTRATION:**

   In this study, water from lakes, rivers, and groundwater is treated to remove impurities before it reaches our faucets. The treatment process involves filtering out large particles, settling out smaller particles, and removing other particles through sand filtration and activated charcoal. Chemical disinfectants like chlorine are also used to make water suitable for human consumption. In a related activity, students create a water filtration column using gravel, sand,

and activated charcoal to examine its ability to remove contaminants.(page no. 22[10])

2.2 Design and development:

The design and development of a water purification system using a pedal system is an innovative solution to provide clean drinking water in areas where access to electricity is limited. The project aims to use the pedal power to rotate a dynamo and generate electrical energy, which will be used to power a water purification unit. The generated energy will be stored in a battery to ensure a continuous power supply to the purification unit. The purification unit will use various processes such as reverse osmosis, activated carbon filtration, and ultraviolet treatment to remove impurities from the water.

To make the system sustainable, the energy source can be changed from a pedal system to other sustainable energy sources such as solar, wind, or hydroelectric. The waste water generated during the purification process can be utilized for other purposes such as irrigation, cleaning, or flushing.

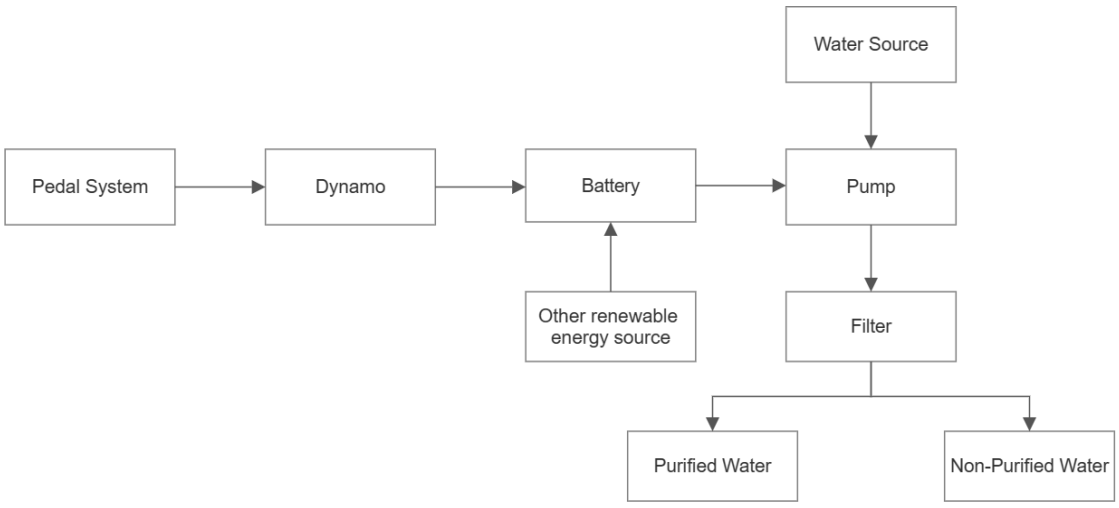

Fig.2: Working diagram of water purification system

Chapter: 3

3.1. Methodology

The methodology of our project involves using a pedal-powered system to generate electrical energy, which is then used to power a water purification unit. The following are the step-by-step details of the methodology:

Step 1: Pedal System

The first step in our methodology involves using a pedal system to generate mechanical energy. The pedal system consists of pedals attached to a chain, which drives a dynamo. The pedaling motion generates mechanical energy that the dynamo converts into electrical energy.

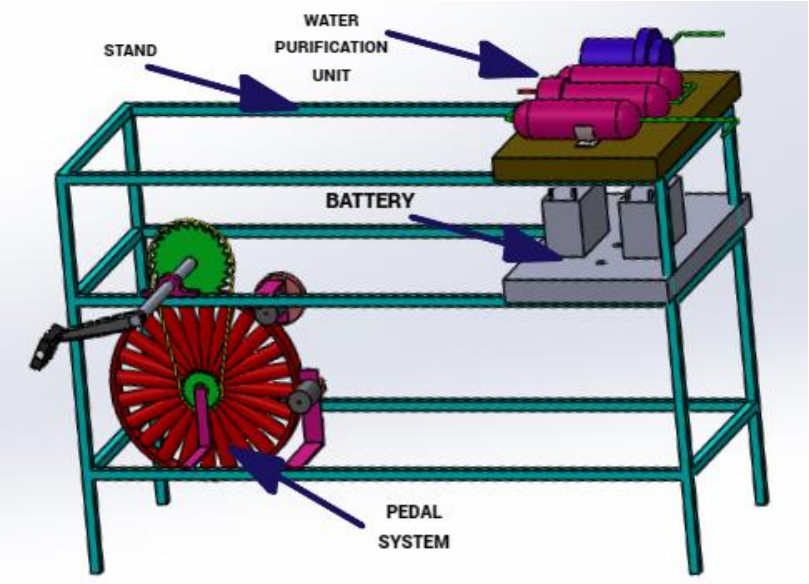

Fig. 3: Schematic diagram of the dynamo, pedal system, and battery connection

Step 2: Battery Charging

The electrical energy generated by the pedal system is then used to charge a battery. The battery is an essential component of our project as it stores the electrical energy generated by the pedal system. This ensures that the water purification unit can be run continuously, even when there is no pedaling motion.

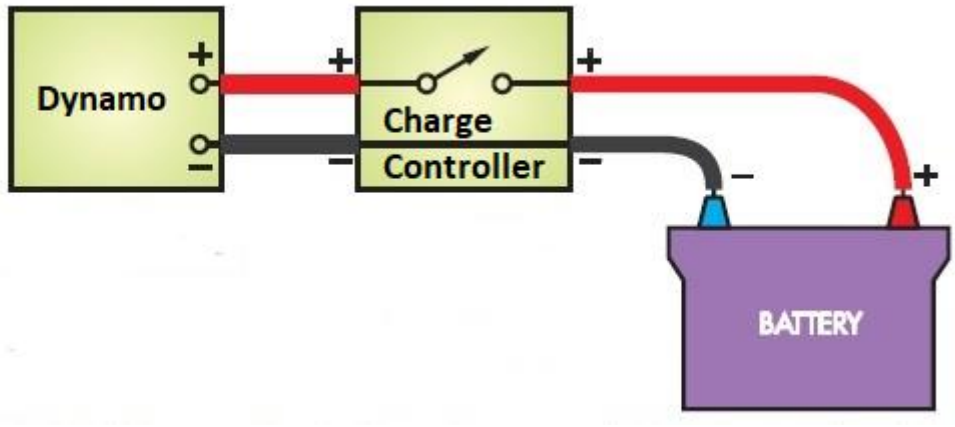

Fig. 4: Schematic diagram of the dynamo and battery connection

Step 3: Water Purification Unit

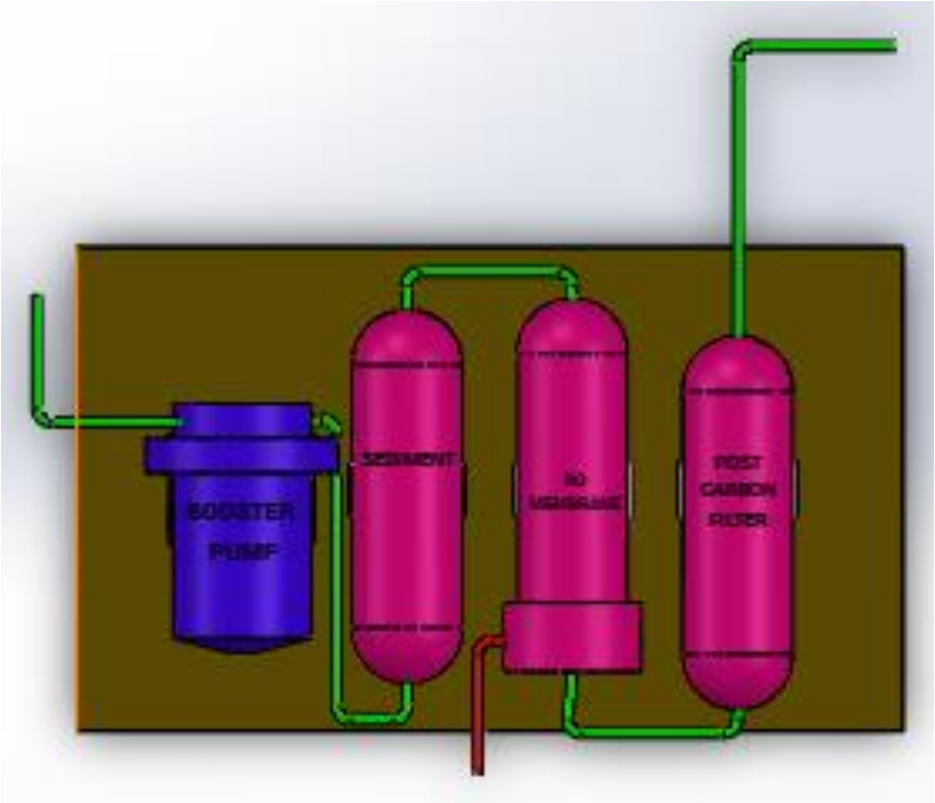

Fig.5: Schematic diagram of the water purification unit

The water purification unit is the central component of our project. It consists of a booster pump and various filters, including sediment filters, activated carbon filters, and reverse osmosis membranes. The battery powers the water purification unit and can treat untreated water to make it safe for human consumption.

Step 4: Water Inlet

The water inlet is the entry point for untreated water into the water purification unit. The water inlet is designed to filter out larger particles, such as sand and gravel before the water enters the rest of the purification process.

Step 5: Booster Pump

The booster pump increases the pressure of the untreated water entering the water purification unit. This is necessary to ensure the water can pass through the various filters and membranes effectively.

Step 6: Filters and Membranes

The filters and membranes in the water purification unit remove impurities and contaminants from the untreated water. The sediment filter removes larger particles, while the activated carbon filter removes organic compounds, chlorine, and other chemicals. The reverse osmosis membrane removes dissolved solids, including salts, minerals, and heavy metals.

Step 7: Treated Water Outlet

The treated water outlet is the final step in our methodology. The treated water is dispensed through the outlet, ready for human consumption. The water is free from impurities and contaminants and is safe for drinking.

Fig:6- A picture of our project

The methodology of our project involves using a pedal system to generate mechanical energy, which is then converted into electrical energy to charge a battery. The battery is used to power a water purification unit with a booster pump and various filters and membranes to treat untreated water. The treated water is then dispensed through the outlet, ready for human consumption.

Chapter: 4

4.1. Results and Discussions

4.1.1. Comparison of TDS of water: TDS stands for Total Dissolved Solids, a measure of the concentration of inorganic and organic substances dissolved in water. TDS levels can impact water's taste, odor, and safety for human consumption. We will use a TDS sensor, an electronic device that measures the conductivity of water and converts it into a TDS reading. By comparing the TDS readings of different water sources, we can determine the relative purity of each sample. This information can be used to select the best water source for treatment and monitor the water treatment processes' effectiveness.

Fig. 7: Measurement of TDS of Initial water, Waste water and purified water

Table of TDS of different water samples

SAMPLE NO.	INITIAL MEASURE TDS OF WATER(IN PPM)	FINAL MEASURE TDS OF WATER (IN PPM)	WASTEWATER TDS OF WATER (IN PPM)	WHAT SHOULD BE FOR DRINKING WATER (IN PPM)	PERCENTAGE CHANGE IN TDS(%)
1	314	41	345	LESS THAN 300	86.9

2	**377**	**54**	**398**	**LESS THAN 300**	**85.6**
3	**393**	**47**	**419**	**LESS THAN 300**	**88**

Based on the results of the table, it can be concluded that the water purification using the pedal system was effective in reducing the TDS levels in the water samples. The final measured TDS levels were significantly lower than the initial measured TDS levels. In all cases, the TDS levels of the purified water were within the acceptable range for drinking water. The percentage change in TDS levels was also significant, indicating a substantial reduction in impurities and contaminants in the water. Therefore, the project was successful in achieving its aim of providing a low-cost and sustainable method for water purification using pedal power. However, further testing and optimization may be needed to ensure the system's reliability and scalability for larger-scale water purification applications.

4.1.2. Electricity Generation: The project aimed to develop a water purification system using a pedal system to generate electricity. As a result, a 12+v battery was generated, which can be used to power the water purification unit and charge other batteries. The generated electricity can also be used for other purposes, making the system sustainable and cost-effective.

Fig-8: Charge Controller

Chapter: 5

5.1. Conclusion

In conclusion, our project on water purification using pedal systems has provided a sustainable and low-cost solution to the problem of access to clean and safe drinking water in areas with limited or no access to electricity. The pedal-powered water purification system utilizes a dynamo to convert mechanical energy to electrical energy, which is then used to charge a battery. The battery powers a water purification unit containing a booster pump and different types of filters, which remove impurities and contaminants from the water.

One of the significant advantages of this system is that it is portable and can be easily transported to areas in need. Additionally, using pedal power ensures that the system is sustainable and does not rely on expensive and often unreliable sources of electricity.

Furthermore, comparing TDS values of different water sources has highlighted the importance of monitoring water quality. These tests showed that water from different sources can vary significantly in terms of quality and can have adverse effects on human health if consumed untreated.

Implementing our water purification system can help improve public health, reduce waterborne diseases, and enhance the quality of life for individuals in these communities by providing them with access to clean and safe drinking water.

While our project focuses on a specific solution to the water purification problem, several other factors contribute to the issue of access to clean and safe drinking water. These factors include inadequate infrastructure, limited resources, and poor sanitation. Addressing these issues requires a comprehensive and multi-faceted approach that involves collaboration between governments, organizations, and communities.

Our project provides a sustainable and low-cost solution to the problem of access to clean and safe drinking water in areas with limited or no access to electricity. However, such solutions must be accompanied by efforts to improve infrastructure and sanitation to ensure everyone has access to safe and clean water. Only through a collective effort can we address this pressing issue and ensure that everyone has access to this essential resource.

5.2. Future Scope

There are several future scopes for the water purification system using pedal power that we have developed. Some of these are:

- **Scaling up the system:** One of the significant future scopes of this project is to scale up the system to cater to more people. By implementing this system on a larger scale, we can provide access to clean and safe drinking water to a larger population and contribute to ensuring everyone has access to clean and safe water.
- **Improving the system's efficiency:** Another future scope of this project is to improve the efficiency of the water purification system. This can be done by improving the system's design or by incorporating new technologies that can enhance its performance.
- **Integration with other sustainable technologies:** The water purification system using pedal power can be integrated with other sustainable technologies, such as solar power, to ensure a constant and reliable energy source. This will help to ensure that the system can function optimally in areas with limited or no access to electricity.
- **Adoption by communities:** It is essential to ensure that the communities the system intends to serve are willing to adopt and use the system. Therefore, future scopes for the project include conducting awareness campaigns and providing training to communities on how to use and maintain the system.
- **Collaboration with government and non-governmental organizations:** Collaboration with government and non-governmental organizations can help scale up the system and ensure it reaches those who need it the most. Such partnerships can also help secure project funding and ensure its sustainability.
- **Smart system:** A smart system can be developed that can automatically adjust the filtration process based on the input water quality. This can help ensure that the output water consistently meets the desired quality standards.
- **Remote monitoring:** The system can be equipped with sensors to monitor the purified water quality. This data can be transmitted wirelessly to a central server for analysis and monitoring. This can be particularly useful for remote areas where water quality is a concern.

The water cleaning system powered by pedaling has many possibilities for the future. These include making it bigger, better and using other eco-friendly technologies. It could also be used by whole communities and partnered with government and non-profit organizations. By doing these things, we can help ensure everyone has access to healthy and clean drinking water.

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    Pedal Powered Water Filtration System- A Review

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    2.5% Assistant Professor, Department of Mechanical Engineering , JIMS Engineering Management Technical Campus Gr Noida,

    India
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    Pedal Operated Water Filtration System (Mobifilt)

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Statement Of Contribution

ADITYA MAURYA	2020MEB1261	In the project, my contributions were multi-faceted. Firstly, I created a 3D CAD model of the project, which provided a clear visual representation of the design and helped the team to understand the project's functionality. Secondly, I assisted in completing the project reports by providing accurate and detailed technical information about the project design. Additionally, I worked closely with the team in the workshop to ensure the project was built to specification and met the required standards also assisted in making water purification unit Lastly, I took on the leadership role and guided the team throughout the project, ensuring everyone was working together effectively to achieve the common goal. Overall, my contributions were vital in the successful completion of the project.
ASHISH JAGARWAR	2020MEB1271	In the project, my contributions involved both technical and physical work. I provided some assistance in creating the 3D model of the project, but my primary role was to assist in the physical work during the workshop. I helped in designing and making the project, and I also played a role in procuring the required materials for the project. Additionally, I assisted in the report writing process and collaborated with different TAs to ensure the project met

		the required standards also assisted in making water purification unit. Overall, my contributions were critical to the successful completion of the project, and I gained valuable hands-on experience in the process.
HRITIK GARG	2020MEB1285	My involvement in the project was diverse in several areas .I had gone to the market two times or nearby Chandigarh to collect it's components and .Additionally, little bit assisted in workshop. I lastly took water samples for TDS (total dissolved solids) analysis. additionally went shopping pieces of equipment, including Dynamo and TDS sensors.
PRATHAM SINGH	2020MEB1301	During the project, I made several contributions that were critical to its success. Firstly, I helped to connect the pipes that were necessary to transport water to the purification unit. I also made sure that the water purification unit was connected properly and functioning as intended. Secondly, when the clean water was not coming out as expected, I worked to identify the problem by using a flow restrictor to determine the root cause. This helped to resolve the issue and ensure that the water was purified properly. Finally, I collected water samples for TDS (total dissolved solids) measurement, which was an essential step in ensuring that the water was safe for consumption. Moreover, assisting in assembling the project and went to the market to purchase different types of equipment like Dynamo and TDS sensors.
SOURABH KUMAR MEENA	2020MEB1315	My contribution was significant and diverse. Firstly, I assisted in purchasing materials from the local shops required for the project also assisted little bit in creating 3D CAD model. Secondly, I had done physically work in the workshop during the designing and building phases of the project. Additionally, I helped in buying materials required during the project, which was necessary to ensure the project was completed on time and within budget. I also assisted in writing the project report. Lastly, I played a significant role in

		designing and constructing the water purification unit, which was a crucial component of the project. Overall, my contributions were essential in the successful completion of the project.