© DEC 2024 | IRE Journals | Volume 8 Issue 6 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV8I6-1712199

Human-Powered Water Filtration Mechanism for Rural and Remote Applications

NIKET ASHOK SHINDE
Assistant Professor, Sinhgad Institute of Technology

Abstract — Pure and clean drinking water is essential for every household, as human life cannot be sustained without it. In rural and remote regions, electricity supply is often unreliable or completely unavailable, making conventional water purifiers ineffective for everyday use. To address this challenge, a pedal-operated water filtration system is proposed, which utilizes human muscle power through a pedal-driven mechanism to filter water without the need for electricity. This project is specifically aimed at communities where access to safe drinking water is limited due to erratic water supply and power shortages, and where sources of potable water are often located far from residential areas. The system is designed to be lightweight and detachable, allowing it to be easily transported or relocated with minimal effort and modification.

Keywords— Water Purifier, Filtration System, Pedal Driven

I. INTRODUCTION

In many villages across India, access to clean and safe drinking water remains a major concern due to the lack of reliable filtration facilities and inadequate electricity infrastructure. Water from natural sources often contains impurities, harmful chemicals, and various microorganisms that can lead to severe health problems, making it unsuitable for direct consumption. In several regions, people are forced to travel long distances just to obtain water, which may still be unsafe for drinking.

The pedal-powered water purifier offers an effective and sustainable solution to these challenges. Operating primarily on mechanical energy, the system eliminates the need for electricity, making it particularly useful in areas where power availability is limited or inconsistent. Since pedaling is a non-polluting activity, the device is environmentally friendly and additionally provides a form of physical exercise for the user. The central objective of this project is to provide clean drinking water by converting pedal-generated mechanical energy into useful filtration power, thereby making water purification accessible, portable, and practical for underserved communities.

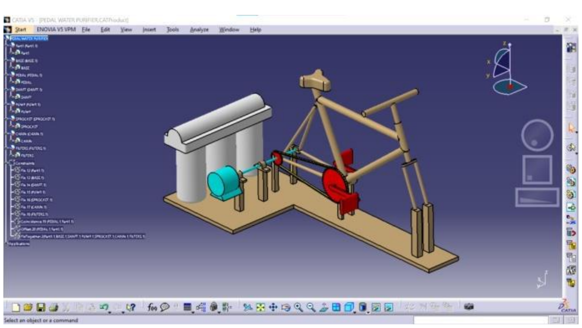
Access to clean and safe drinking water is a fundamental human requirement, yet millions of people around the world, particularly in rural and remote regions, continue to face severe shortages of potable water. In India alone, many villages lack reliable water purification facilities, primarily due to limited infrastructure, irregular water supply, and insufficient electricity. Water obtained from rivers, lakes, wells, and handpumps often contains a wide range of contaminants such as suspended particles, harmful microorganisms, dissolved chemicals, and pathogens that pose serious health risks. Consumption of such untreated water leads to waterborne diseases including diarrhea, cholera, typhoid, and dysentery—conditions that remain major public health concerns in developing areas.

A significant barrier to effective water purification in these regions is the lack of dependable electricity. Most modern domestic water purifiers—whether based on RO (Reverse Osmosis), UV (Ultraviolet), or electrically powered membrane filtration—require continuous power to function. In remote areas where electricity is unreliable, costly, or entirely unavailable, these systems become impractical. As a result, households are forced to rely on unsafe water sources or manually boil water, which requires fuel, time, and effort. Furthermore, in many villages, individuals—especially women and children—walk several kilometers daily to collect water, adding to the physical and social burden.

To address these limitations, human-powered systems offer an innovative and sustainable alternative. Among them, pedal-operated mechanisms are particularly effective because they convert simple human pedaling action into useful mechanical energy. This energy can be utilized to operate a water filtration unit without the need for electricity, making the system both environmentally friendly and economically viable. Pedaling is a familiar, low-effort activity for most individuals and produces no pollution, aligning with sustainable development goals for clean energy and public health improvement.

The pedal-powered water purifier incorporates a mechanical drive mechanism that powers the filtration process. The system may be configured to operate various filtration stages such as sediment removal, activated carbon absorption, microfiltration, or UF (Ultrafiltration), depending on design requirements. Its detachable and portable structure allows the unit to be easily transported, enabling its use in temporary settlements, disaster-relief zones, agricultural fields, or households in remote locations. Additionally, because the system relies on human effort rather than electrical energy, operating costs are extremely low, making it accessible to economically weaker communities.

This project aims to design and develop a practical, reliable, and user-friendly pedal-operated water filtration system specifically tailored for areas where electricity shortages and unsafe water conditions coexist. By harnessing mechanical energy generated through pedaling, the system provides a sustainable solution to the ongoing challenge of providing clean drinking water to underserved populations.



II. LITERATURE REVIEW

Access to clean drinking water remains a major challenge in many developing regions, prompting researchers worldwide to explore low-cost and electricity-free purification technologies. Sodha et al. (1986) were among the earliest to emphasize the importance of alternative water purification methods for rural communities, highlighting that dependence on electricity-based systems limits accessibility. Building on this, Clasen and Cairncross (2004) demonstrated that point-of-use water treatment significantly reduces water-borne diseases, reinforcing the need for decentralized filtration systems.

Several researchers have investigated human-powered purification mechanisms. Ashok Kumar and Sharma (2011) explored manually operated filtration devices and reported their effectiveness in environments with poor electrical infrastructure. Agarwal, Chaudhari, and Patil (2013) studied pedal-powered water treatment units and found that mechanical energy generated through pedaling can successfully drive filtration stages without compromising flow rate. Similarly, Nagaraj and Kiran (2015) designed a pedal-operated reverse-osmosis unit and proved that human-powered systems can achieve adequate pressure for basic filtration processes.

Studies focusing on sustainable water technologies also support the relevance of these designs. Sobsey et al. (2008) evaluated various low-energy purification methods and concluded that simple mechanical or gravity-based filtration can be highly effective in rural settings. Ray, Jain, and Das (2016) investigated biosand and activated-carbon filtration systems, suggesting that these can be integrated into non-electric purifiers to increase microbial removal efficiency. Furthermore, Bhunia and colleagues (2018) proposed hybrid low-energy purification models that combine physical filtration with simple mechanical inputs, aligning closely with pedal-powered systems.

Research in rural development emphasizes the social importance of such technologies. UNICEF and WHO reports (2019) highlight that millions lack reliable access to safe water, especially in regions where electricity is intermittent. Studies by Kumar and Shinde (2020) also note that community-level non-electric purifiers reduce water scarcity issues and lessen the burden on individuals—particularly women—who often walk long distances to obtain water.

III. WORKING PRINCIPLE

In operation by pedaling the cycle man power is converted into mechanical energy which is further converted into electric energy in pump. Rotorof the pump is attached to rare wheel of bicycle which runs due to friction. Pump pumps the water to filter with pressure where dissolved inorganic solids are removed from water.then water is pumped to carbon filter which removes organic matters, chemicals, containments and chlorides using chemical absorption. After carbon filter water is passes through the RO membrane. Here water is converted into pure water, where impure water is collected in container. Water is present everywhere on earth, but it needs to be purified before it can be consumed. Here comes the difficult part. It needs electricity to or fuel along with large systems to purify it and make it consumable. So here we propose a pedal based water purification system that uses pedal power to purify water and make it available for drinking. The design and fabrication of pedal powered water purifier includes sprocket chain system with power generator dynamo along with supporting frame, filters, integrated supporting heating circuit container element with and to achieve this system development. The system uses a pedal fixed sprocket with chain attached to supply circular force to the dynamo to be driven. The power generated by dynamo is then used to store in batteries. The water before getting pressurized is passed through filters to remove large particles and basic filtering. The container on the other end is used to draw pure water from it using a tap. Thus we achieve a pedal powered water purification system as a renewable water purifier.

IV. DESIGN CALCULATIONS

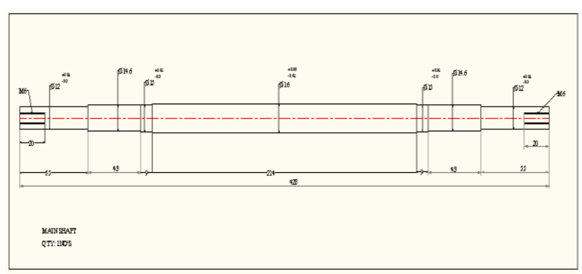
Material selection: - Cross section of link may be determined by considering lever in bending;

The linkage has an section of (25 x 10) mm
Let; t= thickness of link
B= width of link Bending moment;
Section modules; Z=1 6 tB2 Fb=m z =PL 1 6 tB2 = 6PL tB2
Maximum effort applied by hand (P)= 200 N ⇒fb= 6 X 200 X 120 10 X 252 fb =23.02 N/mm2
As fbact< e ⇒ X =1
⇒P = 198.54 N
Calculation dynamic load capacity of bearing L= (C)p P , where p= 3 for ball bearings

SELECTION OF BEARING Spindle bearing will be subjected to purely medium radial loads; hence we shall use ball bearings for our application. P = X Fr+ Y F a

Neglecting self-weight of carrier and gear assembly
For our application F a=0 ⇒P = X Fr Where Fr= Ra
As; Fr< e ⇒ X =1 ⇒P = 198.54 N
Calculation dynamic load capacity of bearing L= (C)p P , where p= 3 for ball bearings The fork pin supports the fork end and is supported in the lever at other end hence
will be subjected to a single shear failure P= 180/ 3 hence pin safe. Π 4 d2

Connecting pin minimum section is 6mm for mounting in in top casing hole. P = 180/ 3 Π 4 62 shear stress = 0.535 N/mm 2 As fsact



V. CONCLUSION

Design and development of energy conservative water purifier is a farming and animal husbandry is the main occupation for many, the research on producing a large scale system with low cost and higher efficiency is being studied. • The major requirement of filters such as sediment filter and carbon filter can be replaced by a single candle purifier known as "life-straw" which consist of physical filtration systems and are tested to kill even protozoans and viruses., • With the growing rates of impurities and pollution in the environment which directly affects the natural and underground water. A simple purification system without the use of electricity is of a great advantage. 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.

VI. REFERENCES

[1] Intestinal Disease and Its Relationship to Drinking Water, In: DhruvDuggal "Bicycle operated pump filter" Publisher IJMERR, Vol. 3, No. 3 e ISSN: 2278-0149(2014)

[2] JayantGidwani, AmitKesheorey, Ratnesh Mishra "Pedal powered water pumping and purification" Publisher IJSART-Vol. 2, Issue 5, e-ISSN: 2395- 1052(2016)

[3] Vishal Garg, NeeleshKhandare, GautamYadav "Design and experimental setup of pedal operated water pump" Publisher IJERT-Vol.2, Issue 1, e-ISSN: 2278-0181(2013)

[4] Curtis, V. And Cairncross (2003), S. Effect of Washing Hands with Soap on Diarrhoea Risk in the Community: A Systematic Review. Lancet Infectious Diseases 3, pp. 275– 281. Howard, G(2006).

[5] Groundwater and Public Health, In: Schmoll O. et al. (eds). Protecting Groundwater for Health:Managing the Quality of Drinking-Water Sources, London, International Water Association Publishing, pp. 3−19. Payment, P., Hunter, P. R. (2001), Endemic and Epidemic Infectious

[6] Fewtrell L., Bartram J. (eds), Water Quality Guidelines, Standards and Health, London, International Water Association (IWA) Publishing, 61−88pp. Garneau, C. McNamara, K. and Chung J. (2008), Peristaltic Pump Project, Unpublished Final Project Report, Team D, ME 340.4, 41pp.

[7] B. Gonzalez ,S. Alzate, J. Cromartie ,K. Hernandez, Advisor: Dr. Andres Tremante (April 7, 2014), Bicycle Powered Water Filtration System, A B.S. Thesis prepared in partial fulfillment of the requirement for the Degree Of Bachelor Of Science In Mechanical Engineering, Florida International University

[8] A. Akinwonmi, S. K. Adzimah, F. Oppong, Department of S. Mechanical Engineering, University of Mines and Technology, Tarkwa, Ghana. 2012,Pedal Powered Centrifugal Pump Purified Water Supply System, Innovative Systems Design and Engineering ISSN 2222-1727 (Paper) ISSN 2222-2871 (Online) ,Vol 3, No.11