

Design and Fabrication of Pedal Operated Reciprocating Water Pump and Filtering System

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Abstract: The development of an improved pedal powered water pump machine was undertaken with the intention of providing a simple cost solution to the problem of delivery of ground water with relatively less effort. This project analyzes the development of an improved pedal powered water pump for rural use. This development was prompted due to the need for pumping systems that does not use electricity as its power source in under developed area the system is composed of a reciprocating pump powered by pedaling it can be used for irrigation and drinking water purposes. It is more productive operated pumping system and is time saving this mechanism is operated mechanically by pedaling therefore it's economical and healthy. A pedal operated water filtration system is a water filtering apparatus which can filter water by using human muscle power via a pedal operated mechanism. This apparatus is preferably mounted on a supporting frame for increased portability. It will be specifically designed to perform three important functions storing water, filtering it and transporting it to the final destination. The aim of this project is to solve purifying drinking water by creating a durable apparatus which is cheap to manufacture and to by which can last for long time in rural conditions and which can be detachable so that it can be mounted on any frame. The system works on the sprocket chain system.

Index Terms: Reciprocating pump. Filter. Chain drive, Sprocket.

Introduction: The idea of pumping water has been in existence since the evolution of man Pumping plays a very pivotal role in the day to day existence of mankind and as a result, different methods have evolved over the years to pump or displace water [1]. Water supply has been a very critical issue, mostly affecting the rural areas. Water is one of nature's most important gifts to mankind [2]. It is one of the most essential elements to good health and as such, it should be readily available to everybody [3]. To address this problem, different methods and techniques have been used over the years ranging from man-pipes and ditches for moving water to where people lived [4]. They were also digging deep wells and making dams to collect and store water powered operated ones down to the more efficient one [4]. Water is a color less, transparent, tasteless liquid that forms the seas, lakes, rivers and rain and is the basis of the fluids of living organism [5]. Our ancestors built many of their villages and towns near springs and rivers so that they could get water easily [6]. There is evidence around the world of early peoples using, A pump is a device that can be used to raise or transfer fluids [7]. Pumps are selected for processes not only to raise and transfer fluids from one point to another, but also to meet some other criterion [8]. This other criteria may be to obtain a constant flow rate or constant pressure according to the requirement [9].

Literature survey:

[1] **Bryan Lee:** the development of a human powered water pump for micro irrigation of rural farmland. Although there are many human powered pumps currently available on the market, they are generally quite expensive and difficult to repair due to a lack of materials and machining tools. With the above in mind, design team prepared a conceptually simple water pump that will be easy to maintain and repair using basic tools while providing enough water flow to irrigate a small plot of farmland.

[2] **Atul P Ganorkar:** the socio-economic conditions of peoples living in villages of developing countries including India, human muscle power can be good alternative to fulfill the energy requirements for performing many activities like water pumping. Pedaling is the most efficient way of utilizing power from human muscles. Keeping these things in mind a pedal operated water pump can be is developed.

[3] **K S Zakiuddin:** usually these devices are very laborious to operate and the operators suffer from various health hazards. Nobody can work at much over 1/5th hp for very long time. According to the survey report, many users of these devices complain about their health problem like muscle pain, reduced body weight, weakness and fever. So the user demands to get a better technology, which requires less manual power and mechanical troubles. Hence to make the existing techniques more user-friendly and uncomplicated more intensive studies are required.

[4] **Sreejith K,Manu Sunny:** conducted the experiment on "Experimental Investigation of Pedal Powered Centrifugal Pump" their experiment consist of three parts – 1. Centrifugal pump 2. Bicycle, 3. Stand. Centrifugal pump is on stand such way that driven shaft is connected to bicycle wheel, bicycle (wheel) rotate so it rotates driven shaft of pump which discharge water from sump. Total head can be obtaining upto 8 m and discharge water 0.00007m³/s.

[5] **Atul.Ganorkar, K.S.Zakiuddin, H.A.Hussain:** conducted the experiment on “Development of Pedal Operated Water Pump” build a bicycle with a mechanism to convert mechanical energy created during use and store for use. Build a device that will harmless and store this energy, and use that energy to offset current energy consumption. When there is cyclic speed fluctuation due to human power we have to use fly wheel. So we can reduce speed fluctuation. Flywheel stores energy so we need to pedal time after 1-2 minutes. Power is transmitted up to 95%.use of sprocket, gear ratio, can minimize torque and increase amount energy generated. An average bike rider travels at speed of 12 mph. Thus speed can produce 1/10 hp. speeds of 18 mph can produce 1/4 hp. at a rate of 1/4 horse power, the human body can pedal continuously for 10 min, but at a rate of 1/8 horse power. continuous pedaling can last up to one hour.

[6] **Arvind T. Wadgure, Ishan P:** conducted the experiment on “Bi-cycle operated centrifugal pump mechanism for water lifting” it’s found that by using bi-cycle operated centrifugal pump mechanism for water lifting we can reduce the human and electric power. These bi-cycle operated centrifugal pumps lift the water up to 15 in feet depth. As per the study over the topic that the bicycle powered water pump is a very advantageous especially for rural areas Paddling for few minute to pump water to a height of 30 feet.

[7] **Mogaji P. B:** conducted the experiment on Development of an Improved Pedal Powered Water Pump” The development of an improved pedal powered water pump machine was undertaken with the intention of providing a simple cost solution to the problem of delivery of ground water with relatively less effort. The pump discharge was $0.0016 \text{ m}^3/\text{s}$ at a head of 20m using a driving torque of 29.5 Nm with estimated efficiency of 90%. It is used for irrigation and drinking water purposes. It is more productive operated pumping system and time saving.

[8] **Jayant Gidwani , Amit Kesheorey:** conducted the Pedal powered water pumping and purification 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 used for irrigation. Delivery head is obtained up to 1.03 m.

[9] **Maanyam. Sairam:** conducted an experiment on Pedal powered water pump. They found pedal operated pump can be construct using local material and skill. This bicycle pedal operated pumps water at 2-3 gallons per minute from wells and boreholes up to 23 in feet depth. Provides irrigation and drinking water where electricity is not available. They can be built using locally available materials and can be easily adapted to suit the needs of local people. They free the user from rising energy costs, can be used anywhere, produce no pollution and provide healthy exercise.

Scope of the project:

The outstanding advantage of water discharging system from the ground floor to first floor or discharging the water from the sump to the collecting point by simply pedaling this unit. The water is carried by the flexible tube relieves the stress free painstaking water carrying through the pot while in staircase walking. Simple construction and plus effort and costless maintenance and anybody can work this unit. Operation is very smooth and in this system we can get more output by applying less effort.

METHODOLOGY

The following methodology was followed by the design of proposed project

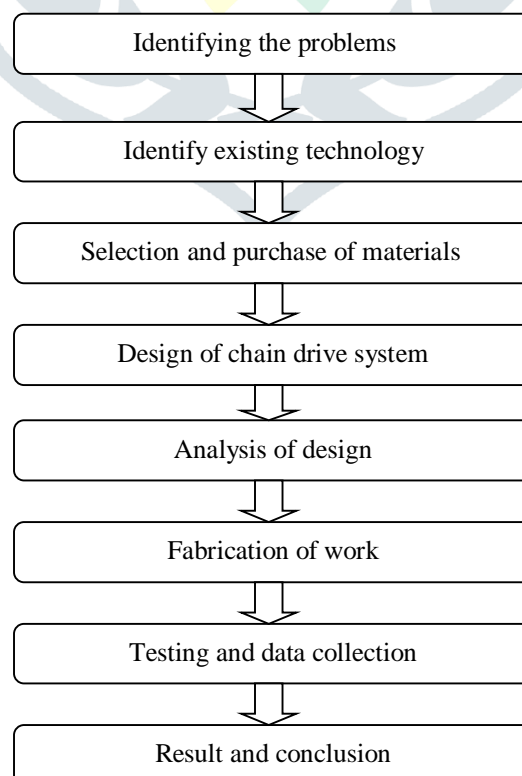


Fig 1: Methodology

Working principle: In this project we generally give mechanical power to the pedal by manual and the pedal is connected to the chain drive sprocket when pedaling starts the chain drive transmits the power to reciprocating pump which is mounted on bicycle via connecting rod the connecting rod is attached with rear sprocket and connecting rod is made to reciprocate the piston rod in the reciprocating pump. The inlet of the pump is connected to the surge tank via pipe. Outlet of the pump is connected to the water purifier for purification process. With the help of this setup we can have a discharge to a certain head if required or we can purify water when needed.

Components of Pedal operated water pump with filter system:

Table 1: Components of pedal operated water pump with filter system

Sr. no	Item	Quantity
1.	Reciprocating water pump	1
2.	Filter	1
3.	Filter pipes	3
4.	chain	1
5.	Chain sprockets	2
6.	Bicycle seat	1
7.	Bolt and nut	4

Component description:

- **Reciprocating water pump:** A reciprocating pump is a class of positive-displacement pumps which includes the piston pump, plunger pump and diaphragm pump. When well maintained, reciprocating pumps will last for years or even decades; however, left untouched, they can undergo rigorous wear and tear. It is often used where a relatively small quantity of liquid is to be handled and where delivery pressure is quite large. In reciprocating pumps, the chamber in which the liquid is trapped, is a stationary cylinder that contains the piston or plunger.
- **Filter:** A water filter removes impurities by lowering contamination of water using a fine physical barrier, a chemical process, or a biological process. Filters cleanse water to different extents for purposes such as providing agricultural irrigation, accessible drinking water, public and private aquariums, and the safe use of ponds and swimming pools.
- **Filter pipes:** A water pipe is any pipe or tube designed to transport treated drinking water to consumers. The varieties include large diameter main pipes, which supply entire towns, smaller branch lines that supply a street or group of buildings, or small diameter pipes located within individual buildings. Materials commonly used to construct water pipes include cast iron, polyvinyl chloride (PVC), copper, steel or concrete.
- **Chain:** Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system.
- **Sprockets:** A chain and sprocket drive is a type of power transmission in which a roller chain engages with two or more toothed wheels or sprockets, used in engines as a drive from crankshaft to camshaft. Chain and sprocket drives are the most common final drive system in motorcycles, a small front and larger rear toothed wheel linked by a roller chain. A chain and sprocket drive is one way of conveying power to the wheels of a vehicle. Though many hundreds of years old, chain and sprocket drives are still used in bicycles and motorcycles as well as other forms of machinery.
- **Bicycle seat:** Your seat must fit your type of riding and your body. The faster you ride, the more likely it is you'll want a narrow, racing-style seat. This is because, a fast-riding position on a bike shifts you forward placing more weight on the hands and feet and reducing a lot of the weight on the seat. Also, as you pedal more vigorously, you spin faster and you don't want interference from the sides of the seat.
- **Bolt and nut:** Bolts and nuts are nearly always used together to fasten a stack of parts together. A nut is a small metallic object, whereas a bolt is basically a screw. A nut is a small hexagonal object made out of metal. It is shaped in a hexagon so that it is easy and firm to grip from all sides. It has a hole in its centre, which has a thread running around it. A thread is a spiral cut groove. It is used as a fastener to a matching bolt. The bolt and the nut are kept together by a combination of their threads' friction. Nuts come in various types, including hex, cap, coupler, wing, turnbuckle and lock.

EXPERIMENTAL WORK

Conceptual design:

The figure below shows the conceptual design of machine that was prepared by using Solid Edge V19. The main parts are IR sensor, aurdino, cutting blade, motors, circuit board, etc

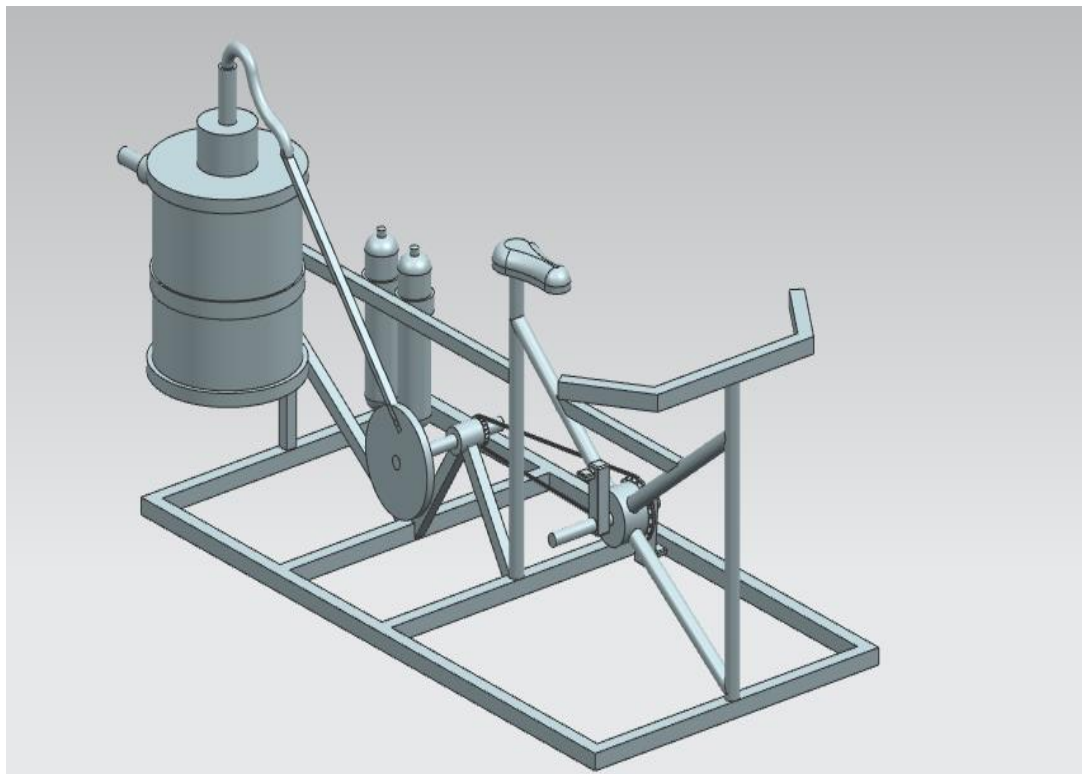


Fig 2: Conceptual design

Actual design:



Fig 3: actual design

Results: The challenge of designing a pedal operated water pump initially seems to be relatively simple, and given adequate funding, the task could be easily accomplished. With this in mind, the team has designed a human powered pump that will provide reasonable performance while being inexpensive, easy to maintain and repair with locally available tools and materials. The aim of the project was to design a novel product from waste material. Although not constructed entirely from waste material. With reference to the objectives of the project, a concept and prototype for a pedal powered water pump based was designed, built and evaluated. The design was specifically developed for use in rural area, but the technology could easily be used in any developing country or area without electricity. Its main advantage over existing technology is its mobility which means that it is suitable for a variety of applications such as irrigation, agricultural, light industrial and domestic water transportation. This project focused on the construction & operation of the reciprocating pump. Our achievement is something we term a moderate success. While many factors have limited the reciprocal pump to a level than what it could actually have been, still we have been successful to demonstrate the worth of a reciprocating pump. Our achievement is something we term a moderate success. While many factor have limited reciprocating pump to a level then what it could actually have been, still we have successful to demonstrate the worth of a reciprocating pump. Our reciprocating pump was a simple homemade type, built on easily available materials and technology. This device serves its purpose to some extent, but with proper course of actions, it can perform still better.

TABLE2: TEST RESULTS

Discharge in ml	400	820	1250	1630	2000	2420	2800	3210	3620	4010	4440
Time in sec	5	10	15	20	25	30	35	40	45	50	55

Conclusions: The whole study over the topic that deal bicycle powered water pump is a very advantageous especially for rural areas. The problem of energy crises is very big in India and many rural powered water pump by use of this project we save electricity and get a particular water head and we supply the water in irrigation. We will operate a water pump by using bicycle mechanism in the project and we can fill the water tank of housing power and get construction work. When we drive a bicycle the driven sprocket will rotates and transmits the power to the rare sprocket through the chain the rare sprocket is connected with connecting lever through crank and made to reciprocate the piston in cylinder. So we operate the pump and deliver the water at a particular head and used for water purification purpose. Drinking water purpose this project is installed any of the place where water. Create a simple and efficient way of pumping water utilizing a human powered bicycle for communities where electricity is unavailable or impractical. Isolated community with or without electricity in need of efficient water pumping. Pumps can be adapted to fit individual community needs. It can also be placed in garden, both gardening & cycling can do simultaneously. Operate pump near best efficiency point. Replace old pumps by energy efficient pumps. Reduce system resistance by pressure drop assessment and pipe size optimization. Provide booster pump for few areas of higher head

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