

DESIGN OF COST-EFFECTIVE BICYCLE OPERATED PEDAL POWER WATER PUMP FOR RURAL AREAS

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Abstract: *This paper contains the basic design and construction of a bicycle operated pedal water pump which may not be useful for large scale industry or power plants but can be used in small scale cultivation, and water supply. For the construction of the pump very low cost materials are required and high skill is not required. The pedal power water pump requires a reciprocating pump which will operated by a bicycle. A reciprocating pump is a hydraulic machine converts the mechanical energy to hydraulic energy. In this pump certain volume of liquid is collected by suction in a closed fitted cylinder and then it is discharged using pressure induced by the piston. The pump set and other parts are setup in a frame bracket in which a foot pedals and drive shaft rotates and makes a motion for connecting rod which in turn causes the piston to move linearly. Pumps are a common means of lifting water from a water source to a useful point of access. This pump can be utilized where no electricity has been reached till now. It produces no pollution, it does not require any electricity, and more over it is very convenient for health purpose.*

Key words: *Discharge, Pedaling, manually operated Pump, Reciprocating pump,*

1. INTRODUCTION

There is a tremendous demand for medium head, low volume pumps in underdeveloped countries. To fulfil that demand, the pumps should be of low cost, reliable and elegantly simple. And furthermore, the pumps should not need high technical ability to control them. The

constructions and style need to be straightforward enough so that native folks can be trained easily for operation and maintenance for the units.

Gasoline and steam-powered pump units requires large fuel consumption, oil for lubrication, and maintenance cost that should get replaced by such pumps that doesn't need any of those factors. On the contrary windmills are too expensive which need to be reduced for industrial units. But the complex and advanced design requires huge expenses. A common drawback for low cost units may be a mechanism to tolerate high winds, their resultant speed and masses. Though these challenges can be taken up in the industries but it cannot be taken up in rural areas, the industries are basically run by individuals or small families. The above-mentioned challenges diverted the researchers to the quest for such a low-cost application which not only becomes a cost-effective solution but also it does not invest much in buying components from market. The enthusiastic researchers have ended up their solution to the challenges through physical efficiency of human being which can be transformed into the required solution. Researchers have found out that the mechanism of running the bicycle and the drives derived from it, can be helpful for the cost effective and innovative solution.

Hence, in small scale irrigation, to extend the cereal production the pedal pump has been introduced. In our country, for poor farmers it's not possible to afford deep driven well, shallow tube wells like modern technologies due to their high cost, instead, they can afford labour intensive technologies like pedal pump, boatman pump etc. due to its low cost. Under the context of our developing country where most of the farmers are poor, the pedal pump appears to be an affordable technology for the cultivation as well as irrigation.

2. LITERATURE REVIEW

Numerous works have been done on this field to the reduction of power consumption and efficient use of man power. The researcher in this paper [1] has performed an experiment on “Development of pedal operated water pump” in which the machine has three sub-systems composed of an Energy Unit: mainly focused on suitable peddling mechanism, speed rise gear pair and Flywheel, a clutch which is torsionally flexible and torque amplification gear pair and finally a water pump unit. The researchers of this paper have produced an important conclusion on the fact that though the human capacity is 0.1hp while doing continuous duty, but with the help of mechanized arrangement capacity can be raised up to 0.6 hp.

From another experiment performed by researcher in this paper [2] on “Pedal powered water pump”, researchers have observed that it arrangements can be made with widely and easy available material so that very skillful associates are not required. Researchers have shown that their proposed design with bicycle operated water pump is capable to provide water at 2-3 gallons per minute maximum to a depth of 23 feet. Its applications can include the fields like irrigation, supply of drinking water in rural areas electricity is unavailable. Moreover, easy availability of materials in local market can be a good prospect of acceptability of this technology by poor people in rural areas. They free the user form raising the energy cost, further it does not create any pollution and it is very good for health.

In the next paper authors have performed research on “Pedal powered centrifugal Pump for pure water supply device” [3] where researchers have mainly focused at the design of that device, which works on the principle of compression and sudden release of a tube by creating negative pressure in the tube. The vacuum created by this mechanism, draws water from the reservoir into the pump while rollers push the water into the filter to purify the water. The design analysis reveals that one revolution of the pedal gives 1.1 liters of water. This design reduces the labour, cost and weariness produced due to transporting and sanitizing the drinking water for use in the homes.

Another research work carried out by the author in this paper [4] concentrates on design and development of pedal pump for low lift irrigation. Their proposed system focuses on the design of a low lift pedal pump for the use of irrigation. The design is composed of different types of piston that are constructed and tested for different suction heads to measure the performance of that machine. The outcome of the pump reveals that, less input power is necessary to maneuverer by one person for almost 2 hrs. continuously without exhaustion. Efficiency of the pump measured as 46.53 % against a head of 1.65 m. It has been observed that, such kind of pump constructed using easily available materials and operated with reduced human efficiency, can be suitable for irrigation in small and distributed farming areas to pump water from a shallow depth of up to 2 meters for the production of vegetables and seed beds.

The authors in this paper have emphasized on designing a pedal power pump using reciprocating pump to convert mechanical energy into hydraulic energy using human maneuverer.

3. PROPOSED DESIGN

The literature review on the burning issue precisely concludes over the fact that the bicycle operated pedal power water pump can be a basic requirement for rural areas. The unavailability of electricity in rural area is still now a very big issue in modern India. Due to this fact production of crop by help of irrigation is gradually becoming a matter of concern to poor people who does not have the capability to purchase electric pump. Agriculture is the foundation of rural development which has been compromised due to this unwanted fact. To relieve from the agony, a possible remedy could be the use of pedal power water pump that can be used in irrigation, cultivation of crop without the electricity. The Figure 1 demonstrates the bicycle operated pedal water pump that can operate the pump by using bicycle mechanism and it is able to fill the water tank of housing, produce power and get help in the construction work. When we start pedaling a bicycle, the wheel of bicycle rotates which provides a chain drive on the sprocket that is linked to the pedal. The chain connects the other sprocket which is attached to a shaft where the pump is installed. With the rotation of the shaft, the connecting rods moves accordingly and creates a reciprocate motion to the piston which in turn causes the supply of water.

Table 1: List of the Material Required

Materials	Quantity
Bicycle Pedal	1
Bearings	4
Chain Drive	1
Shaft	2
Sprockets	2
Delivery Pipe	2
Reciprocating Pump	1

The components used to implement the proposed design has been listed in Table 1. The reciprocating pump is very simple variant of I.C engine. It is a positive-displacement pump that includes the piston pump, plunger pump and diaphragm pump. This kind of pump, as shown in Figure 2, is beneficial to implement discharge of small liquid with large force.



Figure 1: Bicycle Operated Pedal Power Water Pump

The metal chain, shown by Figure 3, that is used to link the rotating shafts mechanically, transmits power efficiently or tracks relative movement when the source moves or rotates. The bicycle acts as the driving unit of this design. Sprockets, as shown by Figure 4, are used to transmit the rotary motion between two shafts. In our proposed design, we used the sprocket in between the pedal and rear wheel, and also in between the rear wheel and the pump drive



Figure 2: Reciprocating Pump



Figure 3: Chain Drive



Figure 4: Sprocket

First of all, the piston provides the required amount of suction force to lift up the liquid with great force. The inlet valve gets closed and the compression is started where a required amount of pressure energy will impart to the liquid. In this part of the phase a huge work is done by the piston compress the liquid and increase the pressure to the desired level. Single acting type reciprocating pump instead can be used where the suction and delivery of the liquid happens in only one side only. But with the double acting reciprocating pump the suction delivery happens

in both sides. The efficiency of double acting reciprocating pump is more than single acting reciprocating pump.

5. EXPECTED OUTCOME

Still now, the available commercial water pumps have produced satisfactory results in terms of efficiency in power consumption, reduction human labour in industrial applications. But due to the unavailability of required electrical power, they have not been used widely in rural areas. These pumps contain centrifugal pumps that are very useful in various industrial application area. The pumps used in the proposed design is not a centrifugal pump but a reciprocating pump. It has been found that reciprocating pumps are not used in industries due to their low efficiency. But in this paper, author have designed a reciprocating pump to be used in rural areas by manual endeavor. The proposed design is expected to be high in efficiency that the existing reciprocating pumps. Moreover, it will be cost effective and employs human labour to produce required output. This design is expected to exhibit better result and produce green environment at a low cost which provides a twofold benefit in conservation of environment and fighting the economical comptonization through manual effort.

6. CONCLUSION AND FUTURE SCOPE

The present-day scenario of technological growth in any field specially in power sector in a developing country like India is compromised with the environmental pollution. In various metropolitan cities and towns, the stigma of unemployment is prevailing due to lack of skilled labor in operating highly sophisticated machines and equipment. Today, pumps are one of the most essential equipment used in industries and house hold applications like lifting of underground water to high rise buildings to fill up the tanks or many other applications like that. In metropolitan cities and town the plenty of electricity and financial growth of people have made them capable to buy modern high efficiency and costly equipment. But still now a large portion of village area which are considered as life line of a agricultural backbone of our country, does not get proper electrification throughout that can benefit the various agriculture based automatic equipment like costly pumps, motors and generators. That is why a large portion of population is dependent on manual efficiency. The author in this paper has therefore tried to design a new pump which utilizes the human efficiency in irrigation and other agriculture related activities just by using easily available bicycle driven pedal power pump. This design not only

benefits the villagers to contribute at the growth of GDP of country but also keep the environment green at a low cost. In future the efficiency can be increase more by modifications in the design of rotor, coupling devices. Apart from that this design is not confined in just in a pump but can be modified to be applied in washing machine, generating green electricity as dynamo or DC voltage generator.

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