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PEDAL OPERATED OSCILLATING CYLINDER RECIPROCATING PUMP

Khushal Das Pillai[1], Ojal Eknath Deore[2], Sanjeev. D. Suryawanshi[3], Dr. Purushottam S. Desale[4]

[1] B.Tech Mechanical Engineering, S.S.V.P.S. B.S.D COE, Dhule 424001 (India)
[234] Department of Mechanical Engineering, S.S.V.P.S. B.S.D COE, Dhule 424001 (India)

Abstract - *It is bicycle pedal operated retrofitting pump using human muscle power. Direct pedal connected connecting rod and oscillating cylinder makes the pump smooth operating. The variable stroke length connecting rod piston assembly to utilize different human muscle power. The proposed project is useful for agricultural and domestic application. It is economically feasible. The pedal operated pump can be constructed using local materials and skill. The water pumping system includes a reciprocating pump. Pumps are a common means of lifting water from a clean groundwater source to a useful point of access, but all pumps have moving parts and are therefore destined to break; proper selection of pump will reduce undesirable downtime and will empower the local community to manage their water source.*

Key Words: retrofitting, rubbered piston, PVC cylinders, calorimeter, reciprocating pump, pedal power

1. INTRODUCTION

A pump is a device used to move gases, liquids or slurries. A pump moves liquids or gases from lower pressure to higher pressure, and overcomes this difference in pressure by adding energy to the system. A gas pump is generally called a compressor, except in very low pressure rise applications, such as heating, ventilating, and air conditioning, where the operative equipment consists of fans or blowers.

Pedal Powered Water Pump (PPWP) is an eco-friendly water pump system. The PPWP works on mechanical energy without electricity. PPWP provides drinking water and irrigation in remote areas where electricity is not available. PPWP is not only free from pollution but also provides healthy exercise [1]. To provide safe drinking-water and adequate sanitation services to all people is perhaps the greatest development failure of the 21st century. The most egregious consequence of this failure is the high rate of mortality among young children from preventable water-related-diseases [2]. The mechanism consists of a single centrifugal pump which is fixed with the rear wheel bicycle. Paddling for just a minute or two is enough to pump 30-40 liters of water to a height of 100 feet. This project could prove helpful for rural areas [3]. The pumping device includes a connecting rod, a crank, an inlet, and an outlet. The rotational motion of the foot pedal of the bicycle drives the chain of the bicycle. Further, the crank of the pumping device converts the rotary motion driven by chain into reciprocating motion of the connecting rod [4].

2. COMPONENTS

2.1 Supporting Frame

A skid for supporting a reciprocating pump assembly, the reciprocating pump assembly including a power end frame assembly having a pair of end plate segments and a plurality of middle plate segments disposed between the end plate segments. The end plate segments each have at least a pair of feet and the middle plate segments each having at least one foot. The skid includes a base and a plurality of pads extending from the base. At least a portion of the plurality of pads correspond to the end plate segment feet and at least another portion of the plurality of pads correspond to the at least one foot of each middle plate segment.

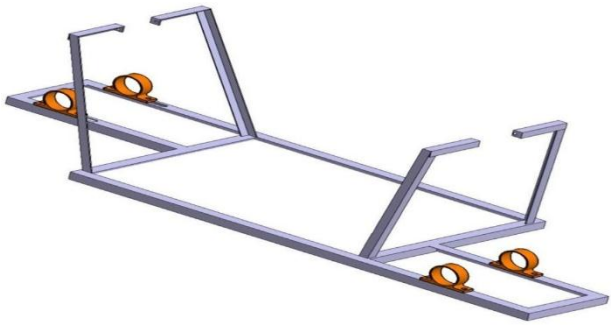


Figure 2.1: Perspective View of fixture and the location of pedestal bearing on which cylinder oscillates.

2.2 Piston Rod

The piston and piston rod are the major components of the reciprocating pump. A piston is a solid metal part. It moves back and forth inside the cylinder to suck and compress the fluid. When the piston moves backward, it sucks liquid inside the pump cylinder, and when it moves forward, it pressurizes the fluid and discharges it. The piston is attached to the crankshaft via a connecting rod. The crankshaft drives the piston. The crankshaft is a rotating component of the reciprocating pump. It is made of solid metal. It is a solid disc that is attached to the piston through the connecting rod. The crankshaft is directly attached to an electrical motor.

Figure 2.2: Perspective view of variable length connecting rod and piston assembly.

2.3 Reciprocating 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.

Figure 2.3: Perspective View of the oscillating cylinder, piston, reciprocating connecting rod and paddle foot rest subassembly.

2.4 Metal Pipe Stand

The metal pipe stand has been carefully crafted to meet the specific requirements of measuring head with a particular emphasis on maintaining structural integrity and stability.

Height and Length: The standpost has a height of 3.5 meters, providing an optimal range for diverse measurement scenarios. The extended length enhances the stand's versatility in accommodating various objects and structures.

Stability and Rigidity: The design prioritizes stability and rigidity to minimize any potential deflection during measurements. This is crucial for maintaining precision.

Hook-on Attachment: The hooks attachment is positioned precisely at a gap of 0.5 meters from bottom to ensure consistent and accurate measurements.

3. EXPERIMENTATION

In this type of reciprocating pump, there is a cylinder, inside which there is a piston designed to move forward or backwards. This piston reciprocates with the help of rods connecting the piston and the rotating crank. In turn, this crank rotates with bicycle pedal help. On the rotation of this crank, the first stroke by the piston is made, referred to as the suction stroke, and then the water is entered into the cylinder. When the suction stroke starts, the crank rotates from an angle of 0° to 180° and the piston then starts moving towards the right side of the cylinder.

Figure 3.1: Perspective view of assembly of pedal operated oscillating cylinder reciprocating pump in accordance with a preferred embodiment of the present invention.

Reciprocating pump is a positive displacement pump, which causes a fluid to move by trapping a fixed amount of it then displacing that trapped volume into the discharge pipe. The fluid enters a pumping chamber via an inlet valve and is pushed out via an outlet valve by the action of the piston or diaphragm. They are either single acting

(independent suction and discharge strokes) or double acting (suction and discharge in both directions). During the suction stroke the piston moves left thus creating vacuum in the cylinder. This vacuum causes the suction valve to open and water enters the cylinder. During the delivery stroke the piston moves towards right. This increasing pressure in the cylinder causes the suction valve to close and delivery valve to open and water is forced into the delivery pipe. The air vessel is used to get uniform discharge. As a result of this process, the vacuum gets created, causing the valve to then open, therefore allowing the water to enter the cylinder.

3.1 Advantages

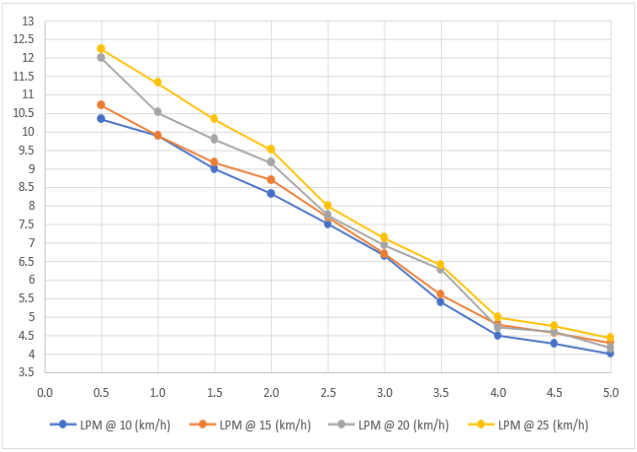
1. Pedal operated oscillating cylinder reciprocating pump items comprising: bicycle pedal, fixture for bicycle, plurality of pedal foot rest mounted on connecting rod, plurality of connecting rods of variable length, plurality of pistons connected to plurality of connecting rods with lock nut, plurality of cylinders mounted on plurality of bearings (preferably pedestal bearings), plurality of inlet valves (preferably non-return valves), and plurality of outlet valves (preferably non-return valves).
2. Retrofitting arrangement of water pump with specially designed fixture for standard bicycle mounting and pedestal bearing mounting of claim.
3. Direct pedal foot rest connected to connecting rod using plurality of bearing and bearing ring of claim.
4. Plurality of oscillating piston cylinder arrangement of claim.
5. One piston cylinder arrangement on left side pedal of bicycle and other on right side pedal of bicycle.
6. Using rear wheel of bicycle as fly wheel in human muscle power water pump.
7. Specially designed variable stroke length connecting rod for utilizing variable human muscle power.

4. RESULTS

In this experiment the test was carried out for discharge of water; the following readings were taken at regular intervals of time. The observations were taken for 10 litres of discharge of present experimentation.

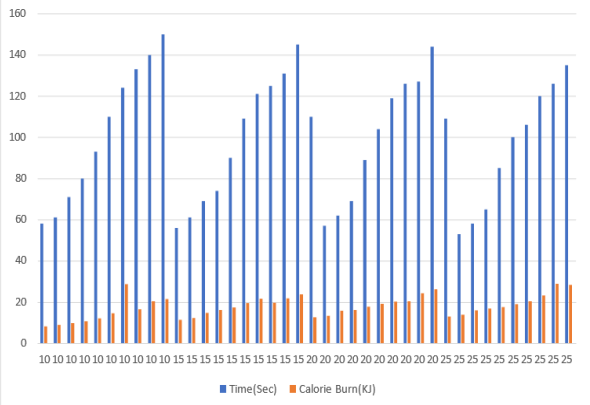
Discharge (liter)	Calorie Burn(KJ)	Head (m)	Speed (km/h)	Distance (km)	Time(Sec)	LPM
10	8.12	0.5	10	0.15	58	10.34
10	8.88	1	10	0.23	61	9.9
10	9.65	1.5	10	0.29	71	9
10	10.55	2	10	0.37	80	8.33
10	11.95	2.5	10	0.45	93	7.51
10	14.4	3	10	0.54	110	6.66
10	28.65	3.5	10	0.59	124	4.9
10	16.40	4.0	10	0.61	133	4.5
10	20.30	4.5	10	0.63	140	4.28
10	21.30	5.0	10	0.67	150	4
10	11.32	0.5	15	0.17	56	10.71
10	12.22	1	15	0.27	61	9.9
10	14.64	1.5	15	0.34	69	9.17
10	16.14	2	15	0.38	74	8.71
10	17.24	2.5	15	0.49	90	7.69
10	19.4	3	15	0.56	109	6.71
10	21.6	3.5	15	0.61	121	4.97
10	19.5	4.0	15	0.63	125	4.8
10	21.6	4.5	15	0.67	131	4.58
10	23.6	5.0	15	0.70	145	4.3
10	12.6	0.5	20	0.19	110	12
10	13.25	1	20	0.29	57	10.52
10	15.62	1.5	20	0.39	62	9.8
10	16.1	2	20	0.44	69	9.17
10	17.65	2.5	20	0.51	89	7.75
10	19.07	3	20	0.58	104	6.94
10	20.04	3.5	20	0.65	119	6.28
10	20.28	4.0	20	0.68	126	4.72
10	24.20	4.5	20	0.69	127	4.6
10	26.10	5.0	20	0.72	144	4.16
10	12.9	0.5	25	0.22	109	12.24
10	13.84	1	25	0.32	53	11.32
10	15.9	1.5	25	0.43	58	10.34
10	16.8	2	25	0.49	65	9.52
10	17.5	2.5	25	0.55	85	8
10	18.9	3	25	0.61	100	7.14
10	20.24	3.5	25	0.69	106	6.41
10	23.2	4	25	0.7	120	5
10	28.8	4.5	25	0.72	126	4.76
10	28.2	5	25	0.78	135	4.44

Graph 1: LPM vs Head vs Discharge



Graph 1 is based on the reading chart where the X-axis represents water discharge (in Litres) and the Y-axis represents height from ground (in meters). It shows the amount of water discharge on Head while keeping the speed constant. Speed was kept constant with the help of a calorie meter which is also equipped with speed measurement capability. It was done to ensure that even if a weak person or child is pumping water from the ground, he/she can carry out the task without much effort.

Graph 2: Time vs Calorie Burn



Graph 2 shows the amount of calorie burn while the equipment was used. This was done so that equipment can be used to measure calorie burn and it can have application in gym and other health centres. To carry out this task, the calorie meter was equipped and calibrated.

5. CONCLUSIONS

- The advantage of the water discharging system from the ground floor to first floor or discharging the water from the lorry to the collecting point is achieved by simply pedaling this unit.
- The water is carried by the flexible tube which relieves the stress of painstaking water carrying through the pot while in staircase walking.
- Simple construction, less effort, costless maintenance, and anybody can work this unit.
- Operation is very smooth and in this system more output can be achieved by applying less effort.
- Conclusion Even when the number of plungers or pistons is increased in a reciprocating pump there is always a minimal gap or discontinuity to the discharge flow due to its speed and the back and forth stroke inside a single or double acting cylinder commonly called reciprocating motion.
- Reciprocating pumps are suitable for moving clean, non-abrasive fluids and abrasive slurries.
- In Fact, The low velocity of reciprocating pumps makes it resistant to corrosion in abrasive-slurry applications.
- Pumps maintain high efficiency when pumping is carried at extremely high liquidity and can easily handle 50% volumes of gas.

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