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Design and Development of Zero Energy Water Lifting Device

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Abstract - *Water is very valuable natural resource, and its availability is limited for agriculture and human use. The major causes for huge gap between potential created and utilized is poor irrigation efficiency due to surface irrigation system. The present work carried out to design and development of zero energy water lifting device, it consists of wheel, paddle, bearing, spiral tube and discharge pipe. The wheel has diameter of 0.6 m with spiral tube length 8 m and diameter 0.02 m. The performance evaluation of zero energy water lifting device is taken. It is fond that it has 0.5 lit/min discharge.*

Key Words: **Discharge, Renewable Energy, flow, Spiral tube, Water, Water wheel pump**

1. INTRODUCTION

India ranks first in the world in terms of irrigated area. The geographical area of India is 328.726 Mha, out of which 184 Mha is cultivated. There is the large amount of use of electricity for pumping the water from the source. There are many sources use for pumping the water viz. river, canal, flowing streams etc. As per this there is a large amount of electricity is required to pump the water, the impact of all this we have to phase the load shading of electricity up to the 12 hours in some cases it may be high. In such load shading places the farmers have to wait for to start his pump to irrigate the field or in some cases he has to work in field at night also.

As per the research there are 14700 villages in India till today are unelectrified (1). The physical location of some villages are such that it becomes very difficult to supply electricity to those areas or even if electricity is facilitated, the environment or weather condition of those areas are so complex that the electricity provides have to do so. In these places farmers only depend on the rainy season farming.

The water lifting pump works on the oils such as petrol, diesel and kerosene. These are non-renewable energy sources and are limited, having higher cost. Therefore, there is need to develop such kind of device which work on the renewable energy sources.

By viewing the load shading of electricity and highest cost of non-renewable energy sources the attempt was done to design and developed the zero-energy water lifting device. This can used to irrigate the field and domestic water supply if water quality is good. The zero-energy water lifting device work on the renewable energy that is flow velocity of the water.

The adoption of zero energy water lifting device save the cost of maintenance, it is used substitute for current pump, use not only irrigation but also for domestic water supply and it is totally independent on electricity or fuel supply.

2. LITERATURE REVIEW

Mishra *et. al.* (2) design and develop spiral tube water wheel pump. The setup required is cheap and efficient. Water pump by using wheel which has a straight pedal, by wrapped a tube around the plane of wheel to form a coil shape. The inlet of tube is submerged in water, when the water flow is strike on pedal of wheel then wheel in rotate water goes down on the tube with atmospheric air which compressed in spiral tube. Course of water contained in the spiral compresses air between them as they travel around the tube and air expelled under pressure into the hollow axel of the wheel. The water which is under pressure rises up the pipe and this process is assisted by the compressed air which lifts water above it in its attempt to escape through the pipe. The spiral tube water wheel pump has the potential to pump water for agriculture and domestic purpose as it extracts water above 50 ft head. Spiral tube water wheel pump is direct replacement of small standard piston pump and just as efficient at pumping a set volume per day.

Patil *et. al.* (3) reported that A wheel on which the spiral tube mounted, and it rotate due to force of water flow which is act on pedal of wheel. Due to rotation of wheel the spiral tube take water in at one end of wheel which is open is at periphery of wheel. This water passes towards the center of wheel into the coil as per revolution of wheel. From this center we get water discharge as outlet at desired head.

Waghmare *et. al.* (4) design spiral tube water lifting pump and done the modification on water lifting pump. This pump designed from cheapest raw material hence the cost of the pump very low. It is totally work on flowing water. This pump can be operated manually, used anywhere and in any season. The study conducted on different parameters such as discharge, head, rpm of wheel, torque applied, size of pipe etc. The analytical study has proved the effect of wheel size on head, effect of torque applied on discharge, effect of torque applied on head etc. It was concluded that spiral tube water

wheel pump was the best substitution for current pump as it can be used in rural areas where frequently breakdown of electricity occurs.

Thompson *et. al.* (5) designed a water wheel and coil pump in Chirundu, Zambia. The pump used for irrigation and made from locally available material. It is observed that the water wheel pump gave 30 lit. of water per min. at a safe gathering area 30 m onshore and at an elevation of 10 m above the river. It is concluded that the water wheel pump had potential to provide water for crop irrigation for many neighboring communities and suggested that this technology with rotating joint must be carefully fabricated.

Tailor (6) The spiral pump a high lift slow turning pump Presented by peter tailor. A 6 feet diameter wheel with 160 feet of 1-1/4 inch inside diameter flexible polyethylene pipe is able to pump 3,900 gallons of water per day to a 40 feet head with peripheral speed of 3 feet per second in 13 no. of coil. If the inlet coil takes in half its volume in both air and water, when maximum pressure is developed by the helical pump, the final cumulative pressure head in the discharge coil will be substantially equal to the coil diameter. A helical Wirtz pump can apparently only pump to a limiting head of 54 feet.

Hermans (7) studied a spiral pump, which had been recreated and tested at wind farm Museum using light weight and inexpensive modern materials. It is resulted that a 6 feet diameter wheel with 160 feet of 1-1/4 inch inside diameter flexible polythene pipe was able to pump 3900 gallons of water per day to a 40 feet head with peripheral speed of 3 feet per sec.

Nagel *et. al.* (8) studied the coil pump and design a model of maximum efficient spiral pump. The pump design of 2 m diameter which constructed at University of the Philippines at Los Banos, using different tube materials and tube diameters. It is concluded that the appropriate design and depth of immersion and size of intake scoop it was not possible to fill the outer coil with water more than 50 per cent of the volume of the outer coil.

Morgan (9) design and develop water wheel pump on large scale for greater water depths. The wheel design of 4 m diameter and tested in condition of 1 m/sec canal velocity, 8 m head of the canal, 16 numbers of paddles to the wheel, 2 spiral coils and 4.21 rev/min of wheel so, it gave the 3697 lit. of water per hour. It is concluded that the required discharged can be achieved by using an appropriate number of coils and a suitable diameter of the wheel.

Ibrahim *et. al.* (10) constructed a water wheel from hardwood and bamboo material with a diameter of 300 cm and width of 40 cm in Padang, Indonesia. It gave the discharge about 100 to 120 lit/min. it is resulted that water wheel continuously irrigate 5 ha area and conclude that the water impact on the blades caused the runners or wheels to rotate and thus develop mechanical energy which was used to rotate it. Also, the water capacity of the wheel depends on the geometry of the water wheel, water availability, size of intake scoop. The water wheel capacity can be increased by increasing the water flows i.e., water velocity or the adding number of intake scoop.

3. MATERIALS AND METHODS

3.1 Materials:

The following are the main components and important materials of zero energy water lifting device. The specifications of the components are shown in Table 1.

Table 1: Specifications and cost of components of zero energy water lifting device.

Sr. No.	Component	Specification	Cost required (Rs.)
1.	Rim/ wheel	Diameter = 600 mm	250/-
2.	Spiral way pipe	Length = 8000 mm	280/-
3.	Intake scoop	Length = 200 mm, diameter = 110 mm	50/-
4.	Paddles	Length = 150 mm, width = 110 mm	520/-
5.	Bearing	Diameter = 25 mm	100/-
6.	Stand	1000 mm× 520 mm× 720 mm	200/-
7.	Other fittings (nuts and bolts, metal wire etc.)		100/-
	Total		**Rs. 1500/-**

1. Experimental site:
The present work was undertaken to study the performance of zero energy water lifting device at K. K. Wagh College of Agril. Engg. and Tech., Nashik (Latitude 19° 59' 0'', Longitude 73 48' 0'') Maharashtra, India.

2. Wheel or rim
It is main component of the device. The diameter of the wheel depends on the depth of the water or head of the water and the amount of water have to pump. For saving cost of the device here, use a rim of the bicycle.

3. Spiral way pipe
It is used to lift and transfer the water from source to the outlet pipe. It is attached in spiral way to the wheel with help of metal wire. One end of pipe is connected to intake scoop and another to the outlet pipe with the help of rotating joint.

4. Intake scoop
It is large opening provided to the spiral way pipe. It is fitted at one end of spiral way pipe which at periphery of the wheel. Purpose to provide intake scoop is to take more quantity of water in spiral pipe.

5. Rotating joint
It is provided at the center of the wheel and another end of the spiral way pipe connected it. It gives free center to rotate the wheel and gives stability to the delivery pipe.

6. Paddles
Paddles are fitted at the periphery of the wheel which help to give the motion of the wheel. As the water velocity pushes the paddles, wheel start to rotate.

7. Stand
The stand made of mild steel angle bars use to give the support of the wheel. With the help of stand the wheel can easily transported from one place to another.

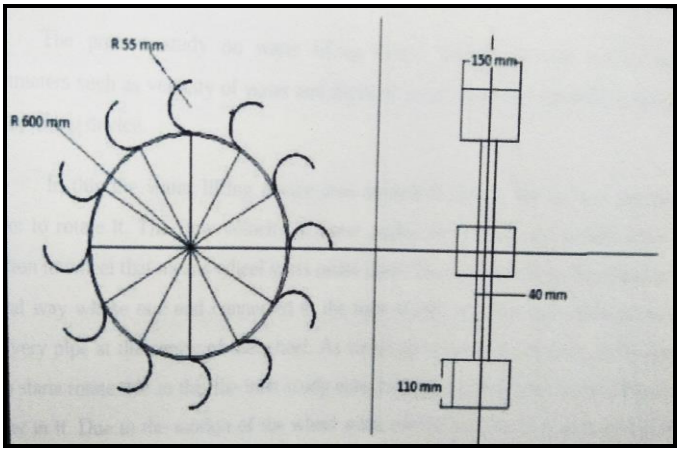

Fig. 1: Front view and side view of wheel

3.2 Methods

The present study on water lifting device depends on the various natural parameters such as velocity of the water and depth of water which are involved in design of water lifting device.

In this the water lifting device uses renewable energy that is flow velocity of water to rotate it. The flow velocity of water pushes the paddles and paddles gives the motion to wheel that means wheel starts rotating. The pipe is fixed on the wheel in the spiral way whose one end connected to the intake scoop and other end connected to the delivery pipe at the center of the wheel.

As wheel start rotate the pipe fix on the wheel also start rotating due to this the intake scoop enter into water and take some quantity of water in it. Due to the motion of the wheel water entered into the pipe goes towards the center of the wheel by spiral way. The continuous motion of the wheel repeats the process and transfer the water to the delivery pipe which fitted at center of the wheel connected to spiral way pipe.

In this way using flow velocity of the water, water can lift through the flowing streams.

1. Discharge
The discharge through the delivery pipe is calculated in terms of lit. per min by using volumetric method. Water is collected in known volume container and time measure to fill that container.

$$\text{Discharge rate (lit/min)} = \frac{Volume\ of\ container\ (lit)}{time\ require\ to\ fill\ container\ (min)} \quad ...(i)$$

2. Velocity of water
The float method used to determine the velocity of the water. To determine velocity of water of the surface channel, the length of the trial section measured. And time measure of float to cross that length section. Several trials are made to get the average time of travel. And the velocity is calculated by following equation.

$$\text{Velocity of flow (m/sec)} = \frac{Distance\ (m)}{Time\ measured\ (sec)} \quad ...(ii)$$

3. Revolution of wheel
For measuring the revolution of wheel tachometer is used.

4. RESULT AND DISCUSSION

The performance evaluation of zero energy water lifting device was conducted and observed results are shown in Table 2. The observed result was discussed in the following headings.

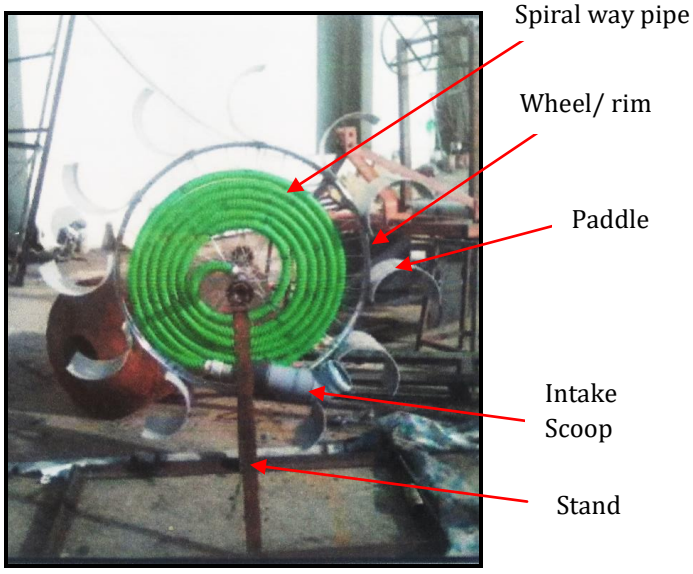

Fig. 2: Actual view of zero energy water lifting device.

1. Discharge

The discharge of the device influenced by various parameter like velocity of water, depth of water and revolution of the wheel. The effort always made to have the maximum discharge from the outlet pipe. To achieve maximum discharge, the device should operate at proper depth and

velocity of water. The average discharge observed of zero energy water lifting device was 0.5 lit/min.

2. Depth of water

The depth of the water was observed 0.44 m in which performance evaluation conducted of device.

3. Velocity of water

The flow velocity of water was observed 0.084 m/sec during performance was evaluated of the device.

4. Revolution of the wheel

The average revolution of wheel was observed during experiment was 5 rpm.

4.1 Suitability of device

The device is suitable under following conditions,

1. The water should be in flowing condition while using zero energy water lifting device.

2. If the velocity of the water is more then the discharge from the device is increased.

3. The height of device can vary with head of water.

Table 2: Observation of performance evaluation of zero energy water lifting device.

Sr. No.	Replications	RPM of wheel	Discharge (lit/min)	Head (m)	Velocity (m/s)
1.	Observation 1	5	0.5	0.4	0.084
2.	Observation 2	5	0.525	0.4	0.084
3.	Observation 3	5.7	0.510	0.4	0.084
4.	Observation 4	5	0.490	0.4	0.084
5.	Observation 5	6	0.490	0.4	0.084
Average		**5**	**0.503**	**0.4**	**0.084**

5. CONCLUSIONS

Presently the water lifting pumps work on electricity and fuel which causes higher running cost. There are also solar energy water lifting pump but it's initial and installation coast is high. It is required to develop such a water lifting pump which work on purely renewable energy and low installation cost. Therefore, zero energy water lifting device developed which work on flow velocity of water and require low construction cost.

The performance evaluation of zero energy water lifting device was observed to be satisfactory. It is suitable for the water lifting from flowing water with appropriate depth. It discharges 0.5 lit/min of water in 0.084 m/sec velocity of water. As the velocity of water stream increases the discharge from the outlet also increases. It is portable hence can be move from one place to another.

REFERENCES

[1] www.bloombergquint.com, March. 2021.

[2] Mishra, P., V. Divakar, H. Sankhe and R. More, "Spiral Tube Water Wheel Pump", International Journal on Recent and Innovation Trends in Computing and Communication, vol.4, Issue 4, pp. 137-139, April. 2016.

[3] Patil, S.H., Sutar S.G., Mirage S.R., Patil A. M. and Nangre B.P., "A Review Paper on Spiral Tube Water Wheel Pump", 5th International conference of emerging trend in Engineering, Technology, Science and Management, pp.186-188, August. 2017.

[4] Waghmare, S.N., Mesri M. M., Lavekar P.V., Misal T. S. and P. C. Nalawade, "Manually operated spiral tube water lifting pump", International Research Journal of Engineering and Technology (IRJET), Vol. 2, pp. 167-169, April. 2015.

[5] Thompson P. L., Milonova S., Rehan M., Mased F. and I. Tromble, "Coil pump design for a community Fountain in Zambia", International Journal for Service learning in engineering, vol. 6, Issue 1, pp. 33-45, spring, 2011.

[6] Tailor, P., "The Spiral Pump, a High Lift, Slow Turning Pump", Retrieved April 6, 2011.

[7] Hermans, J. "Spiral pumps- How to make", http://www.earthgarden.com.au/waterwheel.html, 1998.

[8] Nagel, L.C.A., Real J.G. and A. M. Mazaredo, "Designing a spiral pump for irrigation", WATERLINES, vol. 10, Issue 2, pp. 30-31, October. 1991.

[9] Morgan, P. "The story of water wheel pump by Peter Morgan", http://aquamor.tripod.com/wheel.htm, 1954.

[10] Ibrahim, C. H., Akhyar G., Haron C. H., and C. H. Azhari "Traditional water wheels as a Renewable Rural Energy", The online journal on Power and energy engineering (OJPEE), vol.1, Issue 2, pp. 62-66, 1718.

[11] Muller, G. and C. Wolter, "The breastshot waterwheel: design and model tests", Proceeding of the Institution of Civil Engineers, pp. 1-9, January. 2004.

[12] Punmia, B. C., Pande B. B., Jain S. K. and A. K. Jain "Irrigation and waterpower engineering", published by Laxmi Publibation, New Delhi, 713, 2009.