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Spiral Pumping Wheel Turbine Application Concept for Irrigation with Different Altitudes

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Abstract: *One of the problems of irrigation on agricultural land is the lower position of irrigation water sources. Pumps are needed to raise water to the planting area. Water pumps that are widely sold in the market generally require electrical energy so that their operation requires a source of electricity and operational costs. Spiral pump wheels can be applied because this wheel utilizes the flow of water to pump water without the need for electrical energy. The purpose of this article is to describe the concept of a spiral pumping wheel application for irrigation at different heights. The description is done with simple technical drawings to explain how the wheel works. This description of how it works provides an overview of the mechanisms that occur when this type of wheel is applied. The description is also equipped with aspects of material selection, manufacturing methods and performance aspects. Modifications for increasing the performance of the wheel are also described. An application example is given in the form of a photo of conditions in the field as an additional explanation. A description of the application of the spiral pump wheel has been carried out and is expected to be a reference for the application of this device in the community.*

Keyword: *Concept, Spiral, Water, Turbine, Pump*

Introduction

Community water needs require the use of technology that is able to lift and drain water from sources to agricultural lands and residential areas (Susilo et al., 2022). Irrigation is a means of aqueduct network that is used to drain water and distribute water needs for agricultural land (Riyadhi et al., 2021). Currently, there are many water pumps on the market and there are many types, but even so, these circulating pumps generally require electrical energy to drive them (Sampelawang et al., 2021).

This electrical energy has a weakness, namely the operational costs are quite large and not all places have electricity distributed. Pumps driven by fuel oil will require costs and also limitations in petroleum fuels and from an environmental perspective will trigger global heat (Arlius et al., 2017). Funding has the highest direct contribution value to the effectiveness of irrigation management with pump wells (Wiryawan et al., 2016). A research result shows that the operation of groundwater well pumps for irrigation by farmers requires an average routine operational cost of Rp. 154,381/hour (Albasyra, 2018). Meanwhile, one of the impacts of operating the pump is that the water flowing through the channel decreases, thereby reducing the availability of irrigation water (Murtiningrum et al., 2007).

The flow of irrigation water can be utilized by installing a device, namely a water wheel. Now it has been developed in the form of a water wheel pump, where this water pump functions to pump water without using electricity but with the help of irrigation streams (Marwanto & Asral, 2017). The potential energy contained in irrigation is very likely to be used to drive several small-scale water turbines. Meanwhile, in areas with irrigation with different heights, a spiral tube water pump may also be developed (Asral et al., 2017). The basic idea of the spiral wheel pump comes from the spiral fluted wheel for water pumps (Nizamuddin et al., 2020). For each 360 degree of rotation, part of the spiral is filled with water, and the other part is filled with air. When the pinwheel rotates, air is compressed in each of the spiral circles (Díaz et al., 2020). The energy of flowing water can be harnessed to lift and carry water for irrigation purposes, filling small ponds and also for other rural work in remote areas (Kumar et al., 2020).

Waterwheel pumps can be utilized for low water potentials (Diah et al., 2015). Irrigation performance test was carried out using a hydro-powered mill pump. Wheel pumps can be maximized to channel river water to rice fields with higher elevations (Susilo et al., 2022). The greater the rotational speed (rpm), the greater the resulting water output discharge. In addition, the head of the spiral pump increases with increasing rotational speed (Haryanto et al., 2017).

The application of spiral pumps to pump water in agricultural areas with a height difference between the waterways and agricultural land has the potential to be applied. Spiral pump turbines are relatively easy to manufacture, relatively low cost, installation and maintenance are also relatively easy. The purpose of this article is to describe the concept of a spiral pumping wheel application for irrigation at different heights. This description is expected to be a reference for applications in society.

Metode

The concept description is carried out by describing the spiral pump windmill model in the form of simple technical drawings. This image briefly describes from the aspect of how the wheel works, the potential materials that can be used and examples of their applications. An example of an application is given by displaying a photo of an irrigation canal whose position is lower than agricultural land. This photo is further complemented by a description of the placement of the spiral pump wheel for its application.

The spiral pumping wheel scheme is described as follows:

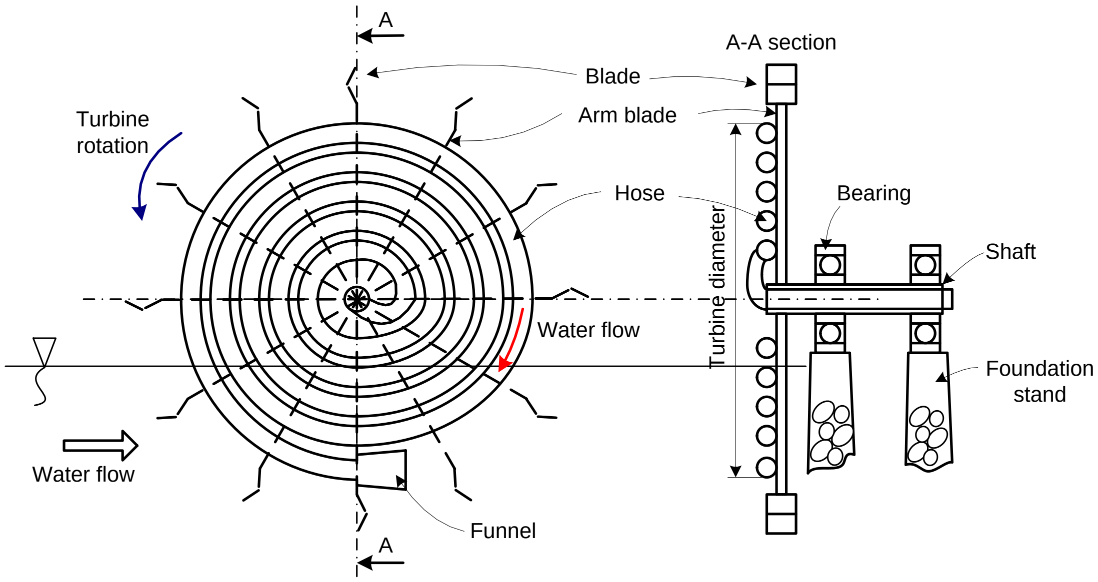

Figure 1. Spiral pumping wheel schematic

Result and Discussion

Spiral pumps harness the potential of flowing water. The water flow will push the blades of the wheel so that the wheel will rotate. With the flow direction to the right according to figure 1, the wheel will rotate counterclockwise (blue arrow in the picture). The water level is slightly below the axis of the wheel shaft. This position causes almost half of the wheel to be immersed in the water flow. When the wheel rotates, the funnel at the end of the hose will carry water. Then there is a flow of water in the hose in a clockwise direction (red arrow in the picture).

Along with the rotation of the wheel, the water in the water hose in the outermost circle will move to the next circle of the hose. And so on until a certain amount of water will reach the part that is close to the spindle axis. This hose is then positioned inside the wheel shaft. Shafts shall be made of perforated pipe material (not solid shafts). Water channels can be selected from water hose materials that are commonly used daily. The shaft pipe is chosen to have a slightly larger diameter than the diameter of the hose so that when the shaft rotates, the hose inside is not twisted.

Blades can be made of metal plates that are lightweight but quite stiff or strong such as zinc, aluminum or galvanized. The dimensions of the blade can be adjusted according to the size of the wheel where the larger or wider the blade size, the greater the thrust for the flow of water. This will affect the rotational speed of the wheel. The blade sleeve can be selected from solid iron material with a diameter of ± 8 mm. The number of blades can be adjusted to the diameter of the wheel where the number of 8 blades is an optimal number. The blade sleeve also functions as a binding frame for the water hose circle so that it does not shift its position. Hose tie-down can be done with cable tie straps.

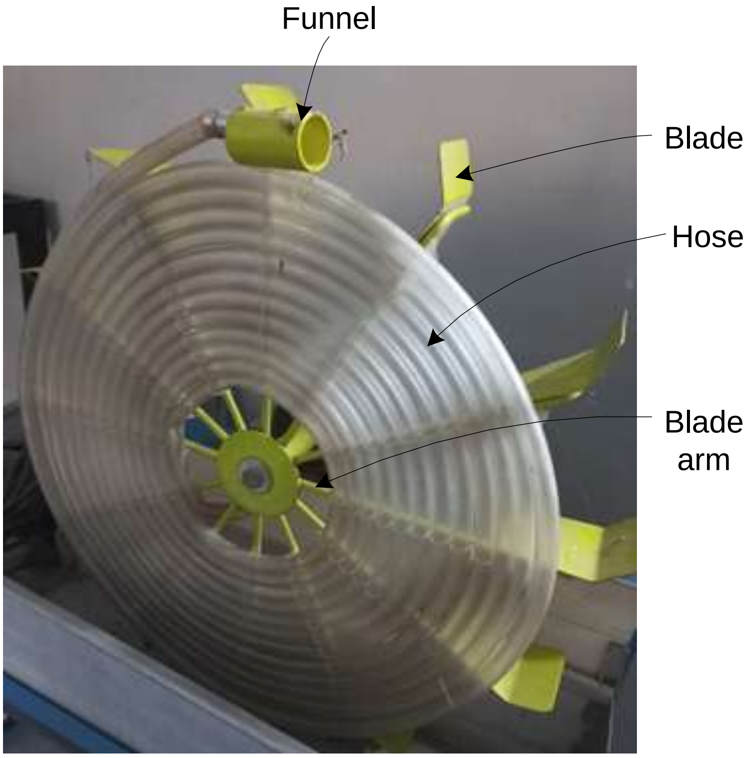

Figure 2. Example of a laboratory scale spiral pump turbine

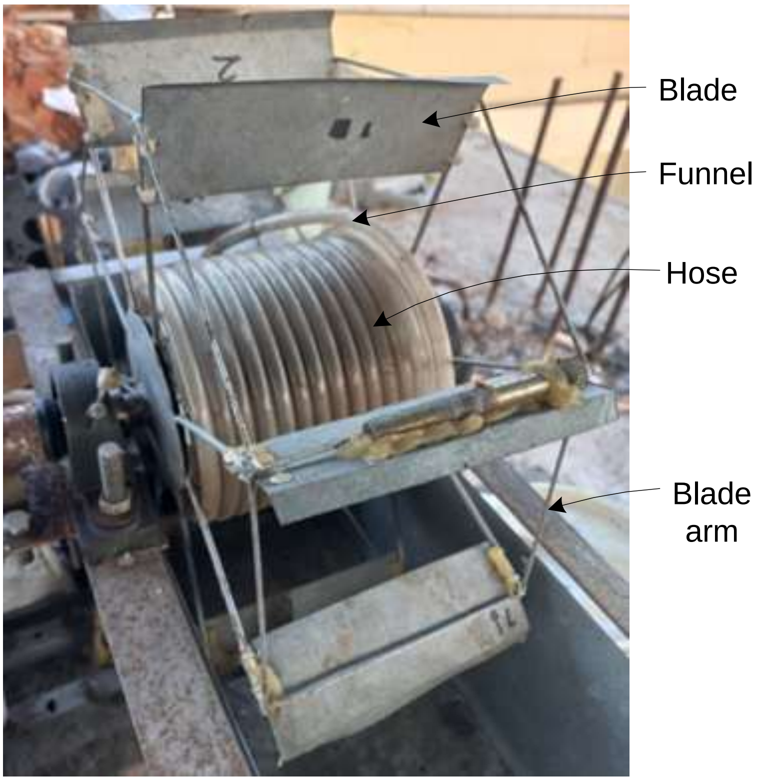

Figure 3. Example of different turbine

The wheel shaft should be supported by 2 bearings in one part because the end of the shaft in the wheel part must be free for the input of the water flow hose. Two pedestals will ensure the wheel is in a strong position when rotating to receive the thrust of the water. The pedestal can use cement building construction or adjust to environmental conditions. The dimensions of this pedestal can adjust to the size of the wheel to get enough strength. The height of the pedestal must be adjusted to the size of the diameter of the wheel where some of the wheel must be submerged in the water flow.

Based on the function and application of the water pump wheel, this device is only capable of lifting water to a maximum height of half the diameter of the hose circle. This relates to part or almost half of the diameter of the wheel that must be submerged in water. This position is intended so that the blades of the wheel get a boost from water for its rotary motion and provide an opportunity for the funnel at the end of the hose to carry water into the hose circle.

An example of the application of a spiral pump wheel can be seen in Figure 2 below:

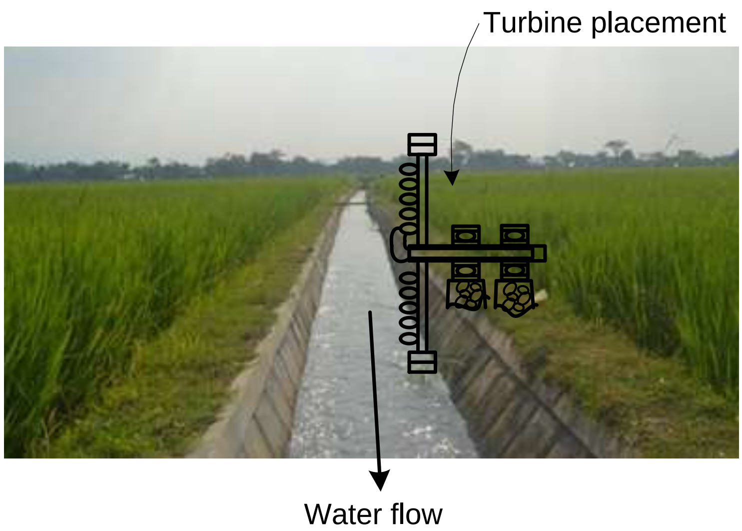

Figure 2. An example of a spiral pump mill application

Increasing the performance of spiral pump turbines can be done, among others:

1. Changing the diameter of the wheel.
2. Change the diameter of the water hose.
3. Changing the number and dimensions of the blades.
4. Adding a circle of water hoses, for example using 2 circles with 2 funnels so that each rotation of the water wheel takes 2 times.

The building of a spiral pump wheel is relatively easy which only requires simple tools such as the process of cutting materials, welding, and installation. In addition, the maintenance aspect is also relatively simple because the wheel construction is not complicated. Installation in a location is also easy because it only requires the installation of a seat or foundation using a cement mixture. Selection of anti-rust metal materials is highly recommended because the water environment has the potential to cause corrosion of the parts of the wheel.

The rotation of the wheel shaft can also be used to drive a generator to generate electricity, although the power produced is relatively small. This is related to the limited potential of water flow and the technical aspects of the mill. The generated electrical energy can be used as a source of energy for lighting at night. Increasing the number of wheels installed in an irrigation canal can be applied to increase the electricity generated.

The application of spiral pump wheels, like other types of waterwheels, needs to consider seasonal conditions, namely the dry season and the rainy season. In the dry season, the flow of water tends to be smaller than in the rainy season. In the rainy season, there is the potential for flooding or excessive water flow which can result in a very high rotational speed of the wheel. This has the potential to cause damage, so it is necessary to create a safety mechanism such as a clutch connection or lock so that the wheel does not rotate when the water flow speed is too high.

Conclusion

A concept description of the application of a spiral pump for irrigation with different heights has been carried out. This device is very suitable for application in agricultural land that has a water source or irrigation that is located lower. Material selection and manufacture are relatively easy and simple. Utilization of streams to lift water from irrigation canals does not require a source of electrical energy so that the operation does not require costs.

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