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A Research Paper on Water Turbines

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Abstract: The water turbine is designed and manufactured according to Tesla's turbine. The alternative energy source for household power requirements is very essential in remote places due to frequent power cuts.It is also important that this source should be compact and easy for common man to run. This thesis aims to design and manufacture a portable water turbine using Tesla turbine theory.This turbine's main aim is to harness the power and kinetic energy of a conventional water supply. Appropriate changes are made regarding the literature survey in the existing design of shaft, plate, and nozzle.Low-head tubular turbine work is primarily based on the smaller flow rate, but the greater flow at different flow channel positions is easy to cause different hydraulic losses, and may have poor stability.A typical case of the low-head tubular turbine unit over the Yellow River, in accordance with the efficiency of the low-head tubular turbine and the hydraulic loss principle, and in accordance with the actual machine guide vane and the surface form of the turbine vane, when turning a fixed vane, adjust the guide vane outlet angle and calculate the computing velocity and energy properties.

Keywords: Breaking jet, Casing, Nozzle, Runner and buckets, Savonius turbine Tesla's Turbine,Water Current *Turbine.*

INTRODUCTION

Ocean energy is one promising renewable resource which could be tapped to meet electricity needs. The conversion of energy from marine currents is quite similar to the conversion of wind energy but there are several differences between them.The installation of a Marine Current Energy Converter (MCEC) underwater offers some benefits such as no noise disturbance to the public, low visual visibility and little land space use but also brings some difficulties such as the need for water and salt proof equipment, difficult and expensive maintenance etc.Ocean currents are relatively constant and travel in one direction only, unlike the tidal currents closer to shore where the changing sun and moon gravitational forces result in diurnal high tides [1].Ocean current velocities are generally lower than those of the wind. This is important, because the power in moving bodies is proportional to their velocity cube[2].

1. *Tesla's Turbine:*

Tesla's turbine is a bladeless turbine that uses series of spinning disks to cover up fluid flow energy through mechanical energy. This turbine is popularly known to have been invented by Serbian mechanical and electrical pioneer Nikola Tesla's turbine in 1913[3].A Tesla turbine consists of a series of smooth disks, where nozzles add a flowing fluid to the disc's bottom. Through viscosity and adhesion of the fluid surface layer, the fluid drags onto the disc.As the fluid slows down and adds energy to the plates, it spirals up into the exhaust core. It's very robust because the rotor has no projections.The Tesla turbine has the characteristic of being in an environment usually operated with a combination of steam and combustion materials and in which the exhaust heat is used to provide fuel supplied to the turbine, having a valve to control the steam supply so that the pressures and temperatures can be regulated to the optimal working conditions.This turbine is chosen is because of its simplicity in nature and principle. The impact of water on the plates induces its rotation by exerting a centripetal boundary layer effect.Inside the casing, the water generates vortex that escapes through the centre of the plate and out of the turbine. This turbine is so flexible it can be used for a variety of applications. This turbine is very stable at high rotational velocities[4].

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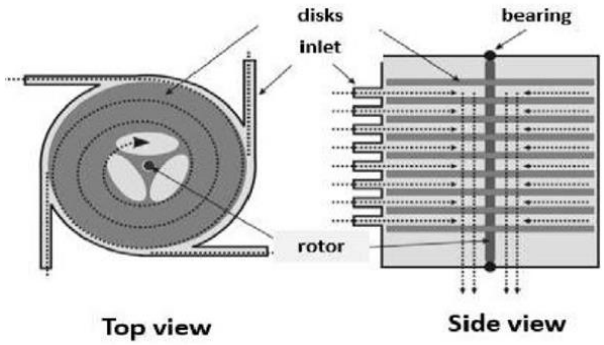

Figure 1: Front and Top View of Tesla's Turbine

There are currently on the market a large variety of turbines that are very costly and effective but very rarely economic and competitive for low-heads. If a turbine can generate a medium amount of power on a regular basis generated by a low head it would provide considerable assistance to people living in remote locations. The modifications planned to make the turbine suitable for applications with small heads. The changes are made to the design of the blade to reduce the losses from the plates during the departure of the water and also the exhaust outside the building[5].

2. *Water Current Turbine:*

There are two types of rotors that should be considered when designing a rotor for marine current generation. These are the Savonius rotor and the propeller rotor each has own unique features.Reasons for selecting Savonius rotor over other forms are given below:

a. Simple design and low cost.
b. A Savonius rotor cannot spin faster than the fluid that rotates it and thus safer for fish.
c. A Savonius rotor accepts flow from any direction and makes simpler or easy installation.
d. Generator placed above the water level.
e. High starting torque to start at lower speed.
f. Maintenance to have a clean leading edge is not necessary.

The above benefits outweigh its low efficiency and slow running speed, making it an ideal economical option to meet the requirement for small-scale electricity[6]. Apparently agreement on the effectiveness of the Savonius turbine is finally reached half a century after its production. Savonius claimed wind tunnel efficiency of 31 per cent and free air efficiency of 37 per cent. Calculations gave 20 per cent as the highest theoretical maximum for vertical air wheels, which could not yield more than 10 per cent in practical performance under the best of circumstances. The Savonius rotor concept is based on the Flettner-designed theory. Savonius used a rotor created by cutting the Flettner cylinder down the central plane into two halves and then moving the two semi-cylinder surfaces sideways along the cutting plane so that the cross-section resembled the letter S shown in Figure 1. In fact, the Savonius rotors are more resistant to mechanical stresses than all wind turbines that run fast[7].

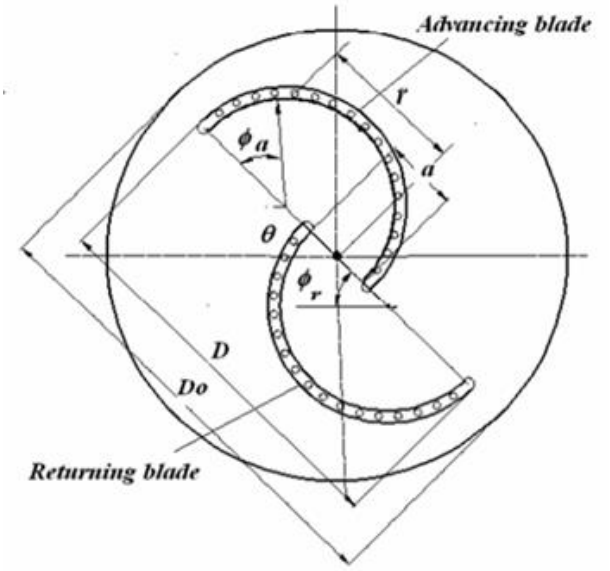

Figure 2: Stationary Savonius with Roud Edge

DESIGN OF WATER TURBINE

All design constraints are examined by carefully reviewing the literature survey and selecting the best design possible for the most effective outcomes for the low-head applications needed.

1. *Parts of the Turbine:*
   a. Breaking jet

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b. Casing
c. Runner and buckets
d. Nozzle

Breaking jet: Whenever it is necessary to bring the turbine to rest the nozzle is completely closed. But the pelton wheel runner continues to revolve due to inertia.A small nozzle is installed in such a way that it guides the jet of water on the back of the buckets to bring the runner to rest in short time[8].

*Casing:*Steel coatings supplied over the pelton wheel runner are known as casing. It does not play any hydraulic role, but is required against accident to provide the runner. It does have the following functions:

a. Prevents accidents.
b. Transmission of water to the tail race.
c. Minimize the wind losses.
d. Stops splashing of water.
e. Facilitates to collect water.

*Runner and Buckets:*The runner is a circular disk holding numbers of cup-shaped buckets which are positioned around its circumference at equal spacing [9]. Runner is normally fitted with bearings on the horizontal shaft, and the buckets are either casted with the disk integrally or attached separately.The seals consist of cast iron, bronze or stainless steel. The inner bucket surface is polished to reduce frictional resistance to the jet of water[10].

*Nozzle:*A pelton wheel nozzle is a circular guide mechanism that directs the water to flow in the direction and controls water flow. A conical or spear needle acts in axial direction inside the nozzle.The principal purpose of the nozzle is to regulate water flow through the nozzle. If the needle is pushed forward into the nozzle, the area will be reduced. As a consequence the water quantity through the jet is also reduced.Similarly, if the spear is pushed back out of the nozzle, the nozzle area decreases and the discharge increase. Spear movement is governed by hand or by automated arrangement of governance[11].

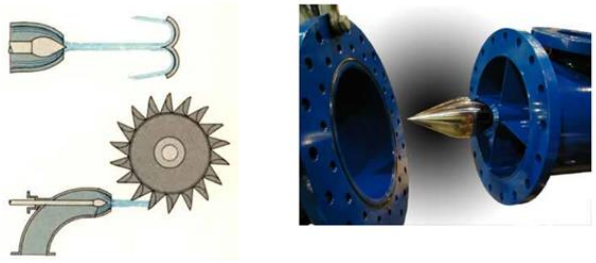

Figure 3: Nozzles

2. *Function:*

Nozzles channel powerful, high-speed water streams against a rotary series of spoon-shaped buckets, also known as impulse blades, which are placed around a drive wheel's circumferential surface.The direction of water velocity is adjusted to suit the contours of the bucket as the water jet impinges upon the contoured bucket-blades.Water impulse energy exerts torque on the bucket and wheel mechanism, rotating the axle; the water stream itself performs a U-turn and exits at the bucket's outer sides, decelerating to a low speed. The energy of the water jet is passed to the wheel in the process and hence to a turbine.The wheel and turbine system is designed to provide optimum power and efficiency, so that the water jet velocity is twice the speed of the spinning buckets.A very small percentage of the initial kinetic energy of the water jet would remain in the stream, which allows the bucket to be drained at the same rate that it is filled, thereby allowing the high-pressure input flow to proceed uninterrupted and without energy wastage.Two buckets are placed side by side on the shaft, allowing the water jet to be split into two equal streams.It balances the side-load forces on the wheel and helps ensure a smooth, stable transfer of energy to the turbine wheel from the fluid jet of water[12].

Figure 4: Pelton Wheel Derives Retation From Impulse Force Produced by the Water Jet.

CONCLUSION

By understanding the Tesla turbine's working principle, the available design is modified with respect to different parameters, and manufacturing is carried out. As the water flows inside the plates into the gap, the velocity continues to drop throughout the flow until the exit.As the axial departure of the water causes the greatest loss in the blades this loss is resolved by changing the design of the plates.Introducing a 26.5 ° bend that is connected to the angle created by the nozzle, this bend allows a more uniform exit of the water without hampering the plate's rotation.The turbine can be used in remote locations where the supply of electricity is shortage or no. It can also be used to restore the power lost in pumps.It's also an important advantage for different domestic applications. A small nozzle is installed in such a way that it guides the jet of water on the back of the buckets to bring the runner to rest in short time. Since it is portable it can be easily transported and used where power is generated from a source of water.

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